A Research article on

Benefits of Glauber's salt in Textile Wet processing

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Abstract:

The Buzz word which is dominating the present decade in the textile processing industry is “Environment aspect”. We could not survive without eco friendly approach at the same time we could not change the existing textile processing system completely, which is taxing the environment heavily. However, we can modify processes in such a way that causes less pollution load and are reusable. By keeping an eye on this objective, Textile Research and Application Development Centre (TRADC) carried out a study by using Birla’s Glauber salt, which is a byproduct of Birla Cellulose’s viscose manufacturing process. In this study, emphasis is given on fabric dyeing by using glauber salt and its comparison with common salt and vacuum salt. Moreover, pollution load caused by addition of all salts are comparatively analyzed. After extensive experimental trials, TRADC got positive results not only in terms of environmental issues but also from fabric processing point of view. The key things like prevention of premature hardness of the dyestuff, low TDS level, less effluent load and better depth of dye shade are achieved during various trials.

Keywords: Glauber’s salt, Reactive dyeing, Dye pick up, color strength

1.1 Introduction:

. In order to understand the depth of the subject, one should understand the basics behind the term “salt” with respect to textile processing.

1.2 Why salt used in Textiles?

is an interesting and basic question in the area of textile processing, particularly in dyeing. The textile substrate and dye molecule, not necessarily should have of homogeneous characteristics to combine with each other. In such case, we require some catalyst to facilitate dyeing action on fabric. Salt plays this crucial role of catalyst. Salt has an extremely high affinity for water. Broadly speaking, Salt is necessary in three ways, firstly, to drive dye into textile during the dyeing process in textile. Secondly, use of salt leads to maximum exhaustion of dye molecules during dyeing process in textiles. Thirdly it is used as an electrolyte for migration, adsorption and fixation of the dyestuff to the cellulose material.

Glauber's salt is a common name for sodium sulfate decahydrate, Na2SO4·10H2O; it occurs as white or colorless monoclinic crystals. Upon exposure to fairly dry air it effloresces, forming powdery anhydrous sodium sulfate. Johann Glauber’s was the first to produce the salt (from Hungarian spring waters). The naturally occurring salt is called mirabilite. Glauber's salt is water soluble, has a salty, bitter taste, and is sometimes used in medicine as a mild laxative; it is also used in dyeing. (1)

1.3 Role of Inorganic salt in Reactive dyeing:

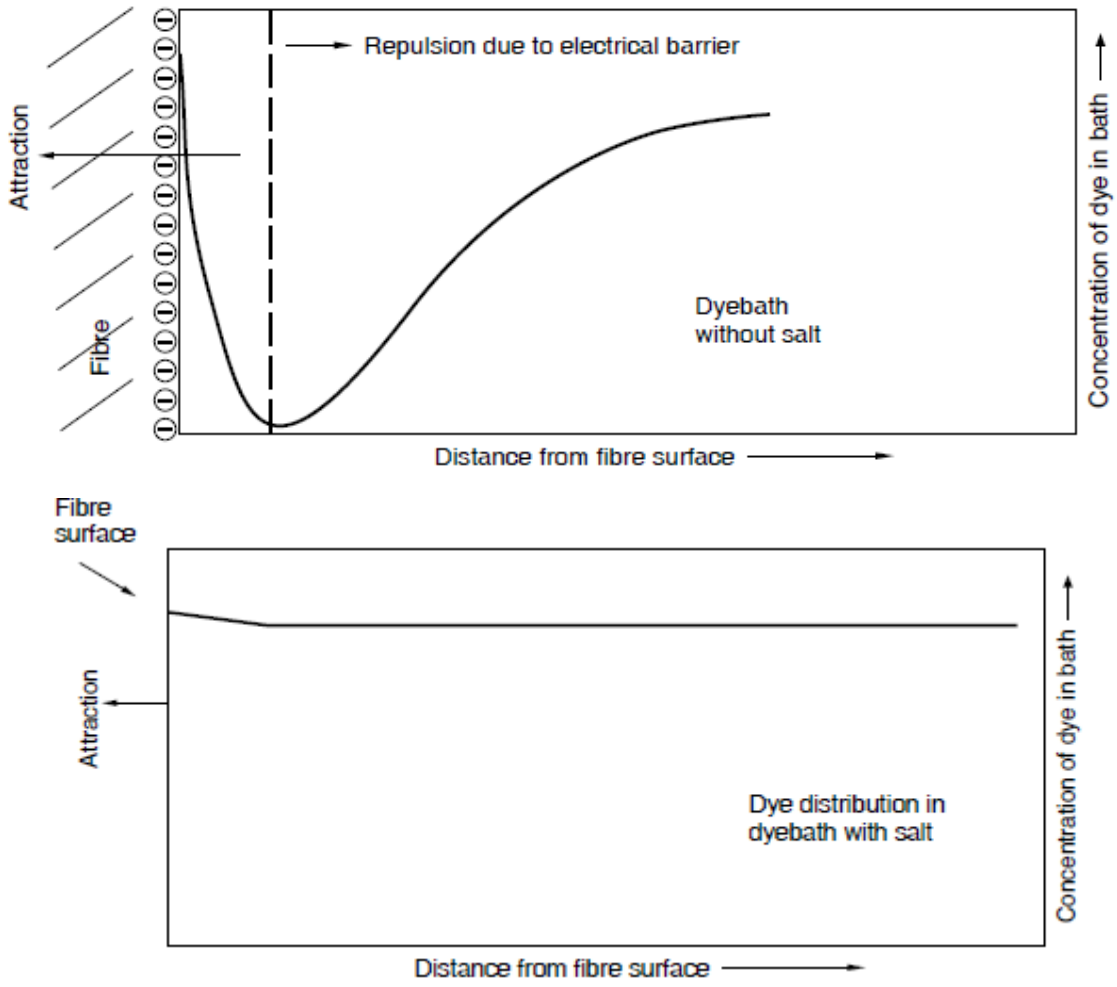
Inorganic salts have two main functions in exhaustion dyeing with reactive dyestuffs:

1. Improving the affinity of the dyestuff
2. Acceleration of the dyestuff's association and lowering of its solubility.

Generally reactive dyes contains sulphonic acid (-SO_3H) group which is insoluble in water. During the manufacturing of the reactive dyes these sulphonic acid

groups are converted into the sodium salt of sulphonic acid (-SO_3Na) which is soluble in water.

Reactive dye – SO_3H + Na^+ → Reactive dye SO_3Na



Generally when the reactive dye goes in the water, it is solublised giving dye anions and sodium cations

Reactive dye – SO_3Na + Water --→ Reactive dye – SO_3^- + Na^+

(Dye anion) (Sodium cation)

1.4 Dyeing Mechanism:

In actual dyeing mechanism vegetable fibres contains cellulose which ionizes in the water

$$Cell - OH \rightarrow Cell - O^- + H^+$$

While reactive dye goes in the water, it is soubise giving dye anions and sodium cations

$$Reactive\ dye - SO_3Na + Water \rightarrow Reactive\ dye - SO_3^- + Na^+$$

(Dye anion) (Sodium cation)

During dyeing both the negative ions of dye and cellulose repels each other in the absence of salt and thus no exhaustion or very little exhaustion is done but in the presence of salt , it will ionize as follows,

$$NaCl \rightarrow Na^+ + Cl^- \text{ (Common Salt) or}$$

$$Na_2SO_4 \rightarrow 2\ Na^+ + SO_4^- \text{ (Glauber's Salt)}$$

Thus the salt neutralize the negative ion of the cellulose and facilating the exhaustion,

$$(Cell - O^- + H^+) + (Na^+ + Cl^-) \rightarrow Cell - ONa$$

$$Cell - ONa + SO_3^- - Reactive\ dye \rightarrow Cell - O - Reactive\ dye$$

(Exhausted dye on the substrate)

Thus the presence of salt in the reactive dyeing increases the affinity of the dye towards the Cellulosic substrate.

Since reactive dyes have low affinity for cellulose, the fixation can be increased by exhausting the dye bath by adding Glauber's salt prior to fixation. The amount of the salts required to produce adequate exhaustion decreases with decreasing

liquor ratio. Thus for pale shades on cotton and viscose rayon 10 to 15 gpl may be used. (4)

1.5 Function of Salt in the Dyeing Process:

- The **salt** in the reactive dyeing **increases the affinity of the dye** towards the Cellulosic substrate.
- **Salt increases** the **exhaustion rate of reactive dyestuffs.**
- **As reactive dyestuffs have a lower affinity**, **more inorganic salt** is required when using reactive dyestuffs in order to **accelerate absorption.**
- While the amount of inorganic salt used varies according to the type of dyestuff used, **recently developed high-fixation dyestuffs with improved affinity** allow the amount of inorganic salt to be reduced.

Due to considerations of effectiveness and cost, both Glauber's salt and common salt (sodium chloride) are used in dyeing. In terms of their role as an inorganic salt, these two are effectively the same because of the sodium cation active in both.

2. Experimental Analysis

2.1 Planning for study-

To study dye-pick up variation using same concentration of Glauber salt and Common salt for Pastel, light and medium shades using combination of dyes. Salt concentration is kept constant for all shades as well as for both types of salts. Following are the specifications used for experiments.

- Machine used: Pilot Plant Infra dyeing Machine
- Material form for trial: 2/40s Viscose fabric
- Material to Liquor Ratio: 1:20
- Water Used: Distilled

Table 1 Salt and Soda concentration for various shades

Type of shade	Salt used	Salt concentration	Soda concentration
Pastel	■ Common salt ■ Glauber salt	40gpl	10gpl
Light	■ Common salt ■ Glauber salt	50gpl	10gpl
Medium	■ Common salt ■ Glauber salt	60gpl	10gpl

2.2 Parameters to study after dyeing

- Evaluation of dyed samples (using common salt and Glauber salt) in terms of Delta E value by spectrophotometer.
- Evaluation of dye strength using spectrophotometer.
- Fabric Handle

2.2.1 Table 2 Strength and Color value comparison for Pastel shade

Particular	Delta Values					
	dL	dC	dH	dE	Remark	Strength
0.011% shade (common salt)	**Std**	**Std**	**Std**	**Std**	**Std**	**Std**
0.011% shade (Glauber salt)	-0.84	2.75	-0.78	2.98	Darker and Redder	23% Darker
0.007% shade (common salt)	**Std**	**Std**	**Std**	**Std**	**Std**	**Std**
0.007% shade (Glauber salt)	-0.88	1.3	-1.61	2.24	Darker and Purple	11% Darker

2.2.2 Table 3 Strength and Color value comparison for Light shade

Particular	Delta Values					
	dL	dC	dH	dE	Remark	Strength
0.3% shade (common salt)	**Std**	**Std**	**Std**	**Std**	**Std**	**Std**
0.3% shade (Glauber salt)	-1.71	0.93	0.6	2.04	Darker and Redder	20% Darker
0.5% shade (common salt)	**Std**	**Std**	**Std**	**Std**	**Std**	**Std**
0.5% shade (Glauber salt)	-1.55	1.43	0.12	2.11	Darker and Bluer	33% Darker

2.2.3 Table 4 Strength and Color value comparison for Medium shade

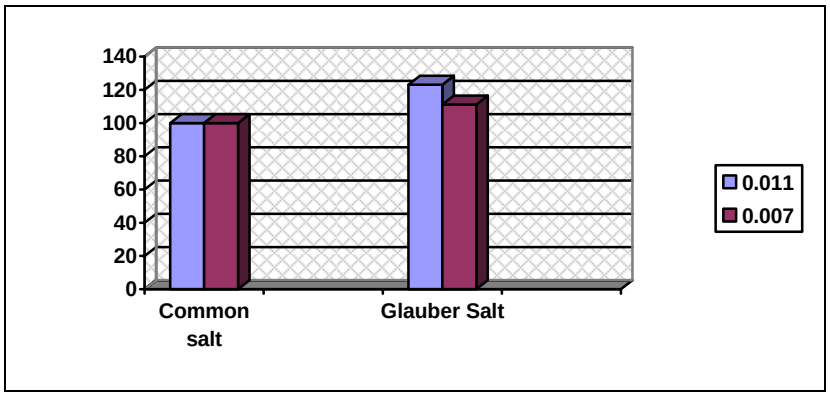
Particular	Delta Values					
	dL	dC	dH	dE	Remark	Strength
1.6% shade (common salt)	**Std**	**Std**	**Std**	**Std**	**Std**	**Std**
1.6% shade (Glauber salt)	-3.19	1.44	0.56	3.54	Darker and Redder	36% Darker
1.12% shade (common salt)	**Std**	**Std**	**Std**	**Std**	**Std**	**Std**
1.12% shade (Glauber salt)	-0.93	0.75	-0.41	1.27	Darker and Yellower	18% Darker

2. 3 Results and Discussion:

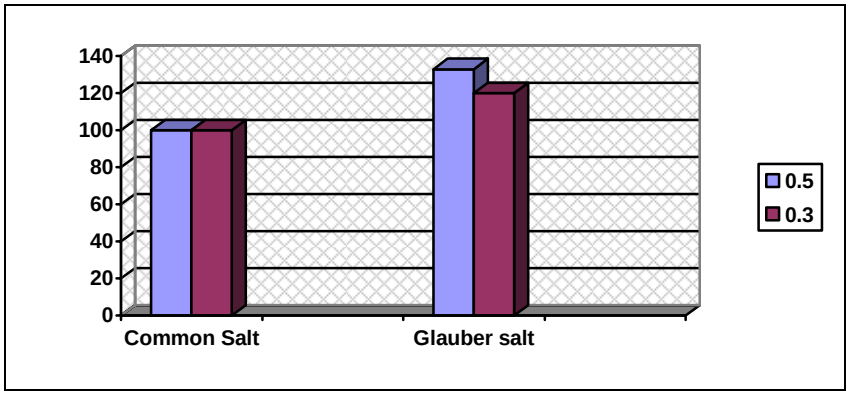
2.3.1 Findings:

It has been found that strength of shade is higher when glauber salt is used, irrespective of the type of the shade. As illustrated in the graph 1, for pastel type of shade, the strength of shade is 23 % higher for 0.011 % shade and 11 % darker for 0.007 % shade.

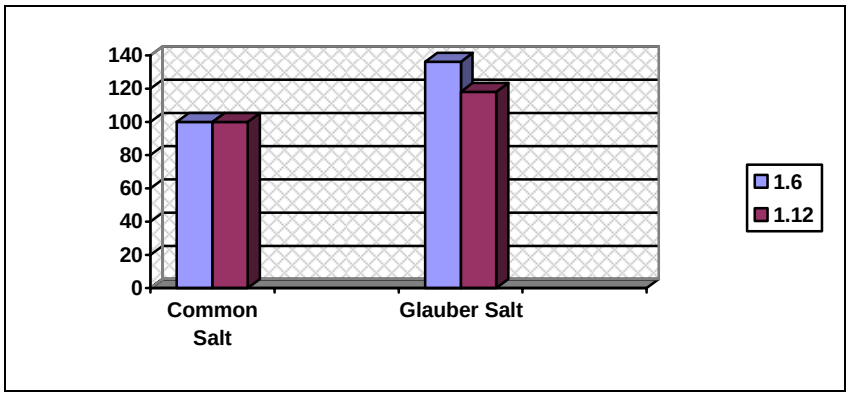
Similarly, for light shade, glauber salt yields 33% and 20 % darker shade for 0.5 and 0.3 % shades respectively



Graph 1 Strength of shade in pastel colour

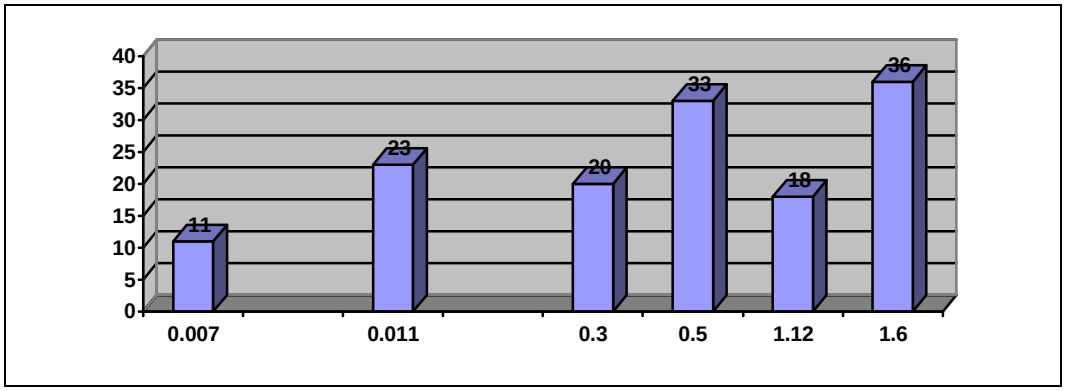


Graph 2 Strength of shade in light colour



Graph 3 Strength of shade in medium colour

As depicted in graph 3, when common salt is compared with glauber salt by using medium shades, the strength of shade is still on higher side. The shades are 36 % and 18 % darker as compared with common salt with 1.6 and 1.12 % shades respectively.



Graph 4 Percent shade versus percent darkness obtained by using G. salt

In graph 4, horizontal axis indicates percent shades for pastel, light and medium shade colour. Vertical axis indicates the percent darkness obtained by using glauber salt when compared with common salt. As illustrated in the graph, we can conclude that the depth of shade increases when shade concentration percentage increases.

2.3.2 Advantage of Glauber salt

- Glauber salt gives higher depth than common salt.
- **Fabric handle** with Glauber salt becomes **smoother** and the fabric handle with common salt becomes rough.

- The **dye exhaustion is higher** by using Glauber salt than common salt and so it is results in **darker shade**. As dye exhaustion is higher by using Glauber salt than common salt and so it is resulted into darker shade.
- As Glauber salt increase the solubility of dye stuff aggregation while common salt lower it.
- Sodium chloride adds TDS in dye bath and adds load on effluent.
- Hardness of water increases due to chloride ions of common salt.
- **Glauber salt does not cause any corrosion** of dyeing machines but common salt causes corrosion of dyeing machines due to presence of chloride ions in it.

2.3.3 Observation:

- **Fabric handle** with Glauber salt becomes **smoother** and the fabric handle with common salt becomes rough.
- Better quality of cost effective dyeing
- In order to get similar depth shade the **concentration of Glauber salt required is less** than common salt.

3. Cost and Eco friendly aspect

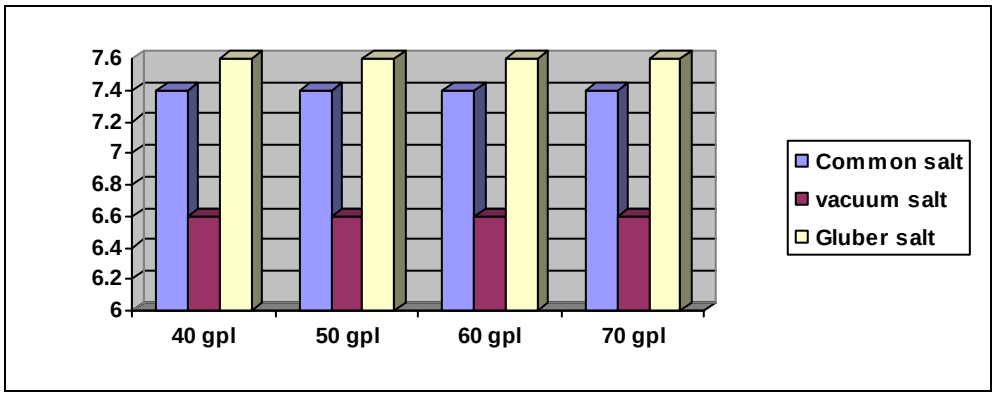
Textile Processing causes more pollution in terms of its effluent, particularly in dyeing and finishing. Drinking water is a major concern, where tones of effluents discharged in water. Effluent is having salt 10 % of the total volume. Dye Effluent is pretreated first then passed through Multiple Evaporator followed by Salt Crystallizer and Primary, Secondary & Tertiary Treatment. During the Dyeing Process, it is better to use Glauber's salt instead of common Salt because it is purer and easier to recover for Reuse. The concentrated Dye Effluent with Glauber's salt is pre treated to remove Colour. It is passed through Multiple Evaporators and gets concentrated. The concentrated solution is chilled in Vacuum Crystallizer and the Glauber's salt is crystallized the crystallized Glauber's salt is centrifuged and taken for Reuse in the Dyeing Process. Technology of Salt Recovery using Glauber's salt gives better Dyeing Results. Salt Recovery and Reuse in a Textile Dye House is a Technological

Breakthrough. The combined Recovery & Reuse of Salt and Water will be a milestone in the Textile Dye House Effluent Treatment globally. The cost of Dyeing increases by about Rs 10 per Kg of Fabric but other Cost Benefit Results are firstly, 90 % of the Salt can be Recovered & Reused. Secondly, every day about 4,500 Kgs of Salt can be recovered and lastly, expected annual Salt Recovery is 1,350 Tons (3)

3.1 Table 5 COMPARISON BETWEEN COMMON / VACUUM & GLAUBER'S SALT ON HARDNESS / TDS & pH VALUES

Salt	Conc. of Salt(gpl)	Hardness of Water as CaCO3(ppm)		Total dissolved Solids(As ppm)		pH	
			Property at Boil		*Property at Boil*		*Property at Boil*
Common Salt	40	275	275	1000	920	7.4	6.8
	50	445	445	1210	1110	7.4	6.6
	60	520	520	1450	1390	7.4	6.6
	70	620	620	1690	1580	7.4	6.6
Vacuum Salt	40	165	165	1180	1090	6.6	7.0
	50	235	235	1550	1330	6.6	7.0
	60	240	240	1870	1560	6.6	7.0
	70	275	275	1920	1820	6.6	7.0
Glauber's Salt	40	10	10	1020	980	7.6	6.8
	50	10	10	1270	1150	7.6	6.8
	60	10	10	1490	1380	7.6	6.8
	70	10	10	1590	1550	7.6	6.8

The values from table indicates that, addition of glauber salt in dye bath as an electrolyte reduces TDS levels to an approximately 15-20 %. This reduces load on ETP in turn provides cost advantages. The hardness of water by using Glauber's salt is least increased which is an important aspect from environmental issue.



Graph 5 Comparison of pH value

As shown in graph 5, glauber salt maintains a normal pH value than common salt and vacuum salt. Following are the some of the values, which are noted down during distilled water test and dye liquor of jet dyeing machine.

Distilled Water test

Parameters	Salt (5gpl)	
	NaCl	Na_2SO_4
pH	6.4	6.6
TDS (ppm)	5146	4916
Visibility	Less clear	More clear

Dye liquor of Jet Dyeing machine:

Parameters	Salt (40gpl)	
	NaCl	Na_2SO_4
pH	6.4	6.64
TDS (ppm)	46190	41177
Visibility	Less clear	More clear

These tests also confirm that TDS level is on lower side and liquor visibility is clearer with glauber salt solution.

4. Conclusion:

This study has better prospect for long term cost benefits and causes less load on environment. Cost reduction will be in terms of less dye requirements for the same shade to that by using common salt. Dyeing quality is superior. Ultimately, use of Glauber salt facilitates dyeing with less quantity, less cost and good quality. The traditional method will become obsolete very soon and replaced by Glauber salt technique. So it is rightly said that

One cannot do today's work with yesterday's methods and still be in the business tomorrow!

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