IMPROVEMENT IN DYEING PROCESS PARAMETERS – A CASE STUDY OF 
SOLAPUR BASED TEXTILE SME

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Introduction

The Indian textile industry is one the largest and oldest sectors in the country and among the most important in the economy in terms of output, investment and employment (E). The sector employs nearly 35 million people and after agriculture, is the second-highest employer in the country. Its importance is underlined by the fact that it accounts for around 4% of Gross Domestic Product, 14% of industrial production, 9% of excise collections, 18% of E in the industrial sector, and 16% of the country’s total exports (Ex) earnings. [1]

The textile sector comprises clothing, apparel, garments, chaddars and bed-sheets, terry towels and allied products. Amongst these products, Solapur (Maharashtra-India) is well known for manufacturing of terry towels and allied products. In fact, terry towels from Solpaur have a market share of approximately 70-80% of the total international demand (for yarn dyed terry towel on Jacquard power loom) [2]. Most of the units in Solapur are of SME categories. But majority of the units are not operating satisfactorily in terms of profits and profitability. Therefore it is the need of the hour to improve productivity and profitability of the sector.

The productivity can be improved by determining the various factors affecting the same. One of these factors is process technology. The authors have conducted studies for improving the process parameters of dyeing process and the same is reported in this paper.

The paper attempts to develop the relationship between temperature of water and quantity of dye stuff and its effect on quality of dyeing for cold dyeing process for ‘M’ Brand using reactive dyes.
The paper is structured as: Literature Review is done, the case study is presented, results of trials are discussed and finally the conclusion is drawn.

**Literature Review**

**Literature Review of Existing Studies**

There are studies in the existing literature based on case studies. The following paragraphs briefly discuss about the existing literature.

After studying the literature and discussion with experts, the authors have identified 39 variables. A structured questionnaire was designed and the data of 194 textile manufacturing units was collected. Factor analysis was done using SPSS Software, which resulted into 8 factors [3].

Mansoor Iqubal et al. [4] have studied reactive dyeing on cotton knits. They have experimented with changing liquor ratios and sort percentage. The data generated will be useful to predict low sensitive reactive dye recipe. Sodium Chloride showed best results at a liquor ratio of 10:1.

Navid Nasir et al. [5] have attempted optimization of wool dyeing with ‘rutin’ as a natural dye by central composite method. They have optimized temperature of Sodium Chloride solution with temperature of wool.

N Meksi et al. [6] have carried out dyeing study of cotton fabric at various temperatures with catalyst. They obtained best results at 40°C and 1% catalyst. The colour yield was maximum at these conditions.

S.J. Mcneil and R.A. McCall [7] have tried the effect of ultrasound at various frequencies on wool dyeing and finishing processes. Ultrasound improved the effectiveness of cleaning, but did not improve dyeing. It showed potential for reducing the chemical and energy requirement of dyeing wool with reactive dyes but not with acid leveling dyes.

Claire Moxhan and Richard Greatbank [8] have used SMED (Single Minute Exchange of Die) for textile processes to reduce setup time. They have suggested an additional step called as “SMED Zero” as a prerequisite for successful implementation of SMED. The prerequisite is classified as - Team Work approach, visual factors,
performance measurement and Kaizen. They have successfully implemented SMED for textile processes.

Dilupa Nakandale et al. [9] have attempted to improve the on time delivery performance using Fuzzy based decision support model for various textile processes. It deals with material shortage (Input and Process Material) and lead time. A case study has been presented using Fuzzy based decision support model, which improved the chances of delivery performance by 27.5%.

C C Wu and N B Chang [10] have attempted to optimize textile dyeing process by non-linear integer programming. The study addresses 4R’s, namely Reducing, Remanufacturing, Reusing & Recycling of the input materials to optimize the processes. It further addresses the selection of best combination of the available materials considering production planning program. Concludes that the consumption of water is reduced by 20% (also conserving the environment).

There are studies on Textile Waste Water Treatment (after dyeing) which have encouraged the reuse of such treated water. (For e.g. Emna Ellouze et al. [11] have studied the method for Enhancement of textile waste water treatment process using Nano-filtration).

**Literature Gap**

After reviewing the literature, it is noted that there are a very few studies reported on improving the productivity of textiles, especially for Solapur based textile SME’s (Yarn dyed Terry Towels on Jacquard power loom). Further the studies have not focused on improving the process parameters for various processes. Therefore it was decided to carry out the study related to process parameters to improve the productivity.

**Objective of the Study**

The objective of the study is to determine the relationship between the temperature of water and quantity of dye stuff and its effect on quality for hank dyeing process for ‘M’ Brand dyes using reactive dyeing. The scope is limited to 100% cotton Yarn and for cold dyeing process only.
**Research Methodology**

After discussing with field experts and academicians, a case study based approach is selected. The case study is presented herewith.

**Case Study**

A terry towel manufacturing industry having 16 looms was selected (in Solapur M.I.D.C.). The general process flow diagram of terry towel manufacturing is as follows (please refer Exhibit 1).

**Exhibit 1: Process flow diagram of terry towel manufacturing**

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Yarn          Doubling  Dyeing  Warp & Weft  Beam Preparation
Packing       Finishing Stitching Weaving
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Out of this processes, dyeing is selected for case study.

Dyeing is process of applying dyes to the yarn (coloring of yarn). There are 2 types of dyeing processes – 1. Cold dyeing    2. Hot dyeing

Cold dyeing is generally carried out at about 40\(^0\)C. Hot dyeing is carried out at 60 to 80\(^0\)C.

The scope of this case study is limited to cold dyeing process on hank dyeing machine for “M” brand dye of reactive dyeing.

Though it is recommended that cold dyeing should be ideally carried out at 40\(^0\)C, most of the textile manufacturing industries at Solapur carry out dyeing at room temperature. In fact, the temperature of water is never measured and recorded. The dye stuff quantity is fixed throughout the year (irrespective of the variations in the water temperature). It means that dye stuff quantity may have been set considering the lowest temperature of the water.

The experimentation was carried out to study the relationship between temperature of water and quantity of dye stuff to achieve the same color shade.

Following were the conditions of experimentation
Yarn: 100% Cotton Yarn
Type of Yarn: 2/20 (Double Yarn with 20 count)
Type of Dye stuff: Reactive dyes
Brand: M brand – light shade
Percentage of dye penetration: 0.1 to 1.5% maximum
Liquor ratio: 9:1
Soaking time: 45 minutes for each stage
PH value of water: 7
Variation of water temperature: 15°C to 40°C

Trials of yarn dyeing at different temperatures were conducted varying the quantity of dye stuff to achieve the M brand – light shade.

Results and Discussion

It is observed that, as water temperature is increased, the dye stuff quantity decreases to maintain the same shade. The dye stuff quantity was 750 grams at 40°C against 1kg at 20°C. The fastness to washing and rubbing fastness also goes on improving as the temperature increases. When the dye stuff quantity is reduced, gpl (grams per litre) of sodium chloride and soda ash is proportionately reduced. The results of the study are presented in Table 1. The graphical presentation of the results is shown in Fig. 1.

Table 1. Readings of temperature of water and quantity of dyestuff

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Temperature of Water (°C)</th>
<th>Quantity of Dyestuff (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>1100</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>1000</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>850</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>750</td>
</tr>
</tbody>
</table>
Fig. 1. Graph of water temperature Vs Qty of Dyestuff

**Conclusion**

As the water temperature increases, the percentage of dye stuff quantity required, decreases to maintain the same shade. This results into proportional reduction of other chemicals like sodium chloride and soda ash. This further reduces the effluent load of the drain water after dyeing which is a measure contributor for conservation of environment. At the same time, the quality of dyeing gets improved (the fastness to washing and rubbing fastness).

**Recommendations**

It is suggested that, the textile industries should start measuring and recording the temperature of water before staring the dyeing process. Accordingly they should select the proper percentage of dye stuff and other chemicals.

This will definitely reduced the cost of dyes and chemicals, simultaneously improving the quality of dyeing. This will enhance their profitability (Y), which is a measure of productivity.

**Future scope**
The scope for future work is suggested as follows,

a. The optimization of the dyeing process can be carried out by using techniques like Design Of Experiments (DOE).

b. The experimentation can be conducted for “HE” and “ME” brands (for hot dyeing).

c. Studies on reuse of textile waste water can be undertaken.
References