DESIGN AND MANUFACTURING OF A LABORATORY SINGEING MACHINE FOR COTTON WOVEN FABRICS

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ABSTRACT: A table top singeing machine was designed for small scale singeing the cotton woven fabric. The machine was comprises of six tension rollers, a burner with adjustable flame angle and runs at the acceptable speed of 10- 30 m min^{-1}. The rollers and burner were made from M.S pipe material. For singeing process trial, a grey fabric sample after manually pre-cleaning was wound on the let-off roller and threaded through the machine rollers up to take-up roller. The flame angle (45^{o}) was adjusted according to the fabric condition (mild or sever singeing). Singeing process was carried out at the speed of 20 m min^{-1} by turning on the machine drive and the flame. The fabric was continuously released from the let-off roller, passed through the burner flame and wound onto the take-up roller. The singed fluff on the fabric surface was manually removed with brush after singeing. The machine can singe only one side of the fabric and suitable for laboratory scale singeing.

Keywords: *Singeing Machine, Burner, Flame Angle, Cotton Woven Fabric, Protruding Fibres.*

INTRODUCTION

Singeing is the process of removing protruding fibres from the yarns and/or fabric surface hence improves the efficacy and wear properties of the fabric [1, 2]. It provides the smooth surface for dyeing or printing. It is first and very important process of textile pre-treatment mostly carried on cotton woven fabrics. However, singing of knitted fabric is also possible [3]. In singeing, protruding fibres are burned by passing the fabric through the burner flame at very high speed. The burning behavior depends on the type of raw material. The cotton cellulosic material has an exothermic pyrolysis and continues burning after ignition by virtue of its own energy; which leaves ash that can easily be removed by washing. Synthetic thermoplastic fibres require steady supply of energy for burning, and have endothermic pyrolysis. When polyester fibre filaments melt, small molten beads are formed which causes hindrance in the subsequent processes. If the cotton woven fabric is pre-treated and then dyed without singeing process, white spot or frosty appearance may be observed after dyeing as shown in Fig. 1 [4].

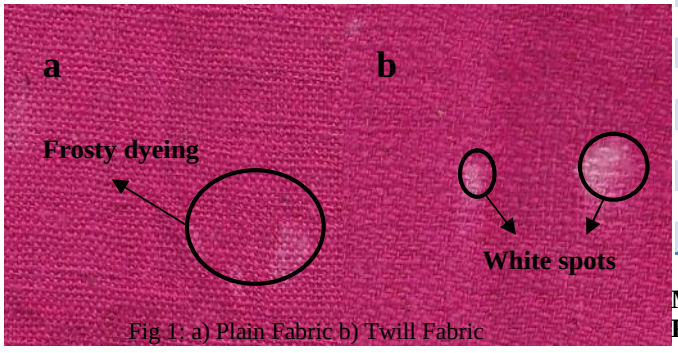


Fig 1: a) Plain Fabric b) Twill Fabric

Therefore, singeing is a pre-requisite process for dyeing or printing industries. The singeing machines has been used in industry on production scale only, which comprise of burners, pneumatic cloth guiders, tension rollers, nylon bristle pre and post brushes [5 - 9]. However, no singeing machine is available for research and testing purpose on a laboratory scale. Therefore, this paper introduces the new design, manufacturing and process efficiency of a table top, easy to install singeing machine on a laboratory scale. The machine was designed and later manufactured in such a way that all the objectives of singeing process could adequately be achieved. The important considerations were burning of the surface protruding fibres and fibrils only, maintaining the fabric tension during singeing, and adequate machine speed. The machine comprises of six rollers and an open gas flame through a burner connected to gas supply/cylinder, while pre and post cleaning performs manually using nylon brush. The rollers and burners were from M.S. pipe material. For smooth running of machine, the let-off and take-up rollers were knurled. The machine was manufactured for cotton woven fabric but may be used for other cellulosic woven fabrics. The singeing process assessment was also done to validate the concept.

MACHINE SPECIFICATIONS

The specifications with which the singeing machine was designed are given in Table 1.

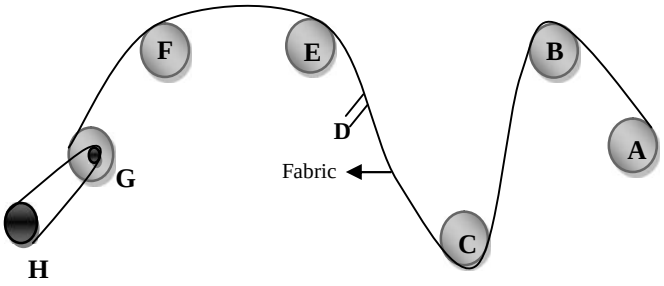
Table 1. Singeing Machine Specifications

S. No.	Parameters	
1	Machine Speed	10 – 30 m min^{-1}
2	Flame Height	1 – 1.5 inch
3	Flame Angle	45^{0}(60^{0} & 90^{0} optional)
4	Flame Color	Blue
5	Fabric Length	3 meters
6	Fabric Width	13 inches
7	Roller Width	15 inches
8	Singeing burner	One side
9	Wound	Clockwise (tightly)

MAIN COMPONENTS OF THE MACHINE

Roller/Cylinder: The table top singeing machine comprised of six rollers (see Fig. 2). The diameter of each roller was 1.5 inch. The light cylinder weight provided an appropriate tension on the fabric during singeing. In addition, it bears the fabric load and eases forward movement of the fabric sample without slippage. For smooth running of the rollers, bearing was attached on both sides of the rollers. M.S pipe material, rust free that has 7 - 9 times more life than stainless steel, was used for rollers.

Burner: Gas cylinder was used for the methane gas supply and connected to the burner as shown in Fig. 3. Whereas, a



A = Let-off **roller**, B, C, E and F = Tension rollers, D = Burner, G = Take-up roller, and H = Motor.

Fig. 2: Cross-sectional View of the Fabric Threading on the Machine

burner was made-up of M.S pipe and had nineteen nozzles (2 ± 0.5mm diameter each). Nozzles were placed at an equal distance throughout burner width in order to evenly singe the fabric.

Uneven singeing (variation from one end of fabric to another) leads uneven pre-treatment and dyeing of the fabric. The steel plate was used to guide the flame of the burners. The flame angle can be manually changed by unscrewing the burner on the machine frame.

Fig. 3: Burner

Motor: Quarter horse power motor drives the take-up roller at a speed of 10 -30 m min^{-1} using a V-belt (FM23). The adequate machine speed ensures uniform and even singeing.

WORKING PRINCIPLE OF MACHINE

Entry: The fabric samples are pre-cleaned (removing fluffs on the fabric surface) using nylon bristle brush and then wound on the let-off roller threading through all the rollers (See Fig. 2). This is because the residual fluff deposited on the fabric surface during fabric manufacturing can catch fire and burn the fabric. The care must be taken when winding the fabric on the let-off roller so that the fabric is wrinkle and crease free and adequately stretched. Otherwise, it will cause improper and uneven singeing and leads to variation in subsequent processes such as dyeing and printing.

Singeing Unit: Burners are the heart of singeing unit and are set to provide a flame angle of 45^0 (tangential) for mild singeing and 60^0 and 90^0 for intermediate and sever singeing respectively [1, 2, 11]. The fabric passes through the burner between rollers C and E and the fabric surface is exposed to open flame (see Fig. 2). Steel plates were provided to guide the flame and to avoid flame spreading. The fabric sample can be re-wound backwards if singeing is required for both sides. As the fabric passes through the singeing unit, it is wound on the take-up rollers.

Take-up roller: The speed of singeing machine is controlled by take-up roller, which is driven by a motor (see Fig. 4). After singeing, fabric sample is taken-off and manually post-cleaned with nylon bristle brush for removing the burned pills or fluff on the fabric surface.

Fig. 4 The Laboratory Singeing Machine (Top View)

SINGEING PROCESS ASSESSMENT

A cotton woven fabric (172 g m^{-2}, grey) was assessed for protruding fibres on a Motic B1 microscope at the magnification of 100x. Reduced protruding fibres on the fabric surface were observed after singeing the fabric as shown in Fig. 5.

Fig. 5: Before and After Singeing Process

CONCLUSION

The working principle of laboratory singeing machine is same as the industrial singeing machine. It comprises of six rollers, one is take-up roller driven by motor, one is let-off roller and rests are tension rollers. These rollers were made-up of M.S pipe material. The burner was installed in the center of the machine and connected to a methane gas. The flame angle is adjustable. The machine is easy to install in the laboratory and can efficiently and evenly singe the cotton woven fabric.

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