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# How to Reduce Production Cost of Sizing

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***Abstract---*** **Sizing is an essential step for warp yarn preparation in the weaving process of textile supply chain. It is carried out to impart additional protection to warp yarns in order to withstand the abrasive forces during weaving. Although sizing is an inevitable process and offers substantial benefits during weaving, there are several problems associated with sizing. Cost is always a prime management concern and this paper approaches to explore more efficient sizing recipe in terms of selecting size chemicals compared to the traditional recipe.**

***Index Terms---*** **Cost effective, Process, Recipe, Size chemicals.**



## I. Introduction

Textile industry is considered as one of the largest consumers of water in the world. Processing a ton of textiles is estimated to consume about 80-100 $m^3$ of water that is subsequently released into the environment [1-3]. Textile processes such as sizing and desizing consume considerable amounts of water, energy and chemicals and are mostly responsible for the toxic effluents released into the environment from textile plants [4-5]. Several reports have highlighted the problems and concerns on processing textiles and their effects on the environment [1]. Most countries, especially in the European Union have enacted several regulations to limit the environmental impacts of textile processing. Among the various textile processes, sizing and desizing account for 40-60% of the effluent load in a textile mill [3].

Sizing of warp yarn is a process to coat the yarns with elastic film and bind fibers of yarns so that yarns may be strong enough to resist the mechanical strain in weaving and to improve weaving efficiency. The protection to yarns imparted by coating the yarns with chemicals is called sizing. Starch and starch derivatives, carboxymethyle cellulose, and synthetic polymers such as polyvinyl alcohol (PVA) have traditionally been the most widely used sizing chemicals [5-7]. Although starch and starch derivatives are extensively used for sizing, there can be several limitations including less than satisfactory sizing performance and difficulties in desizing starch based size [8]. Relatively low price, good performance properties and easy biodegradability are the advantages of starch whereas

PVA is preferred for the excellent sizing performance and easy desizeability although PVA is more expensive than starch. However, PVA accounts for 45% of the total BOD load but does not degrade in textile effluent treatment plants and is reported to persist in water released from treatment plants [9-10]. Attempts to recover and reuse PVA and other sizing agents and limit their release into the environment have been technically challenging and economically unviable [11-12]. A significant proportion of the dyes and chemicals used for textiles which are released into effluents are reportedly hazardous to the environment [13]. In addition to the primary ingredient, sizing chemicals contain many other additives such as waxes and lubricants, softeners, emulsifiers, and finishing and wetting agents. Sizing and desizing contribute significantly to the effluents generated in a textile plant and are reported to be responsible for about 50–80 % of the chemical oxygen demand (COD) in textile waste water [14].

However, focus of this paper is limited to cost of sizing. Aim is to explore best combination of size chemicals for warp sizing from factory production data in order to reduce the cost of production, particularly by cutting chemical cost during sizing process.

## II. Materials and Machinery

Yarn : 100% Cotton, 9 Count Open End (OE) yarn, Rotor yarn.

Sizing ingredients : Starch, Binder, Softener

**Starch:** Starch is the main sizing ingredient that coats the warp yarn with a film and imparts smoothness by binding the projecting fibers to the yarn surface. The viscosity of the size solution is controlled by the amount of starch, the recipe, and degree of mechanical mixing, temperature and time of boiling.

**Binder:** These materials penetrate into the yarn and contribute in increasing yarn strength. These materials can be used as an independent gum and substitute of starch products.

**Softener:** The hard-fragile film is softened by addition of softener. They increase flexibility of yarn after sizing. Tallow, Soap, Japanese wax, Modified wax, Artificial wax.

**Size Chemicals Used:**

- BK-1500 (Modified Starch)
- EH-Size (Modified Starch)
- CMS-60 (Modified Starch)
- B-120 (Modified Starch)
- M01 (Binder)
- M06 (Binder)

- M12 (Binder)
- Wax (Softener)

**Machine Specification (Sizing part):**

| | |
|---|---|
| Brand | : Ben Size Tech |
| Machine Speed | : 30-40 m/min |
| Squeeze Pressure | :16.4 kN |
| No. of Squeeze Roller | : 02 pair |
| No. of Emersion Roller | : 02 |
| No. of Size Dryer | : 14 |
| Preparation Tank Temperature | : 90˚C |
| Storage Tank Temperature | : 94˚C |
| Size Box Temperature | : 90˚C |
| Cooking Time | : 25-40 minute |

## III. Methodology

In this paper, 9 Count OE rotor 100% Cotton yarn of 3,000 meters has been used. Normal recipe chemicals such as BK-150 as starch, CMS-60 and B-120 as modified starch, M01, M06, M12 as binders and Wax as softener have been used. After the cost-reduction process, almost same chemicals with a different modified starch and bit different concentration were used. Through some changes in size chemicals, production cost reduced significantly.

At first different sizing agents according to recipe were taken manually in the mixing tank or preparation tank and water was supplied by the pipe in the mixing tank. A fan was circulated for mixing agent. Temperature was maintained in the mixing tank by steam. Then the mixed or prepared liquor was supplied to the storage tank. From this storage tank liquor is supplied the size box by pump. The concentration of the size liquor was checked by the refract meter because different concentration will have to use for different warp set. The liquor in the size box was measured with a sensor to regulate the specified level. Generally size level was maintained by passing 180mm size liquor when this level comes down to 120-130 mm then regulating valve is open pass the size liquor and maintain the level. The temperature of the size box was maintained by the steam. Simultaneously the application of the pneumatic squeeze presser with air cushion cylinder was there to regulate the squeeze presser and achieve the uniform size pickup.

## IV. Results

For typical sizing of 9OE Cotton yarn, 3,000 meters of warp yarn, 675 litres of water, cost of traditional and cost effective recipe is as per following-

**Traditional Recipe:**

| Sl. No. | Chemical Name | Origin | Amount (Kg) | Price $/kg | Cost ($) |
|---|---|---|---|---|---|
| 1 | BK-1500 (Modified Starch) | Thailand | 25 | 0.77 | 19.25 |
| 2 | CMS-60 (Modified Starch) | Thailand | 40.25 | 1.95 | 78.49 |
| 3 | B-120 (Modified Starch) | Thailand | 17.25 | 0.68 | 11.73 |
| 4 | M01(Binder) | France | 3 | 4.8 | 14.4 |
| 5 | M06(Binder) | France | 0.25 | 4.8 | 1.2 |
| 6 | M12 (Binder) | France | 0.35 | 4.8 | 1.68 |
| 7 | Wax (Softener) | Thailand | 4 | 1.8 | 7.2 |
| | | | | | Total= 133.95$ |

**Cost -effective Recipe:**

| Sl. No. | Chemical Name | Origin | Amount (Kg) | Price ($/kg) | Cost ($) |
|---|---|---|---|---|---|
| 1 | BK-1500 (Starch) | Thailand | 22 | 0.77 | 16.94 |
| 2 | EH Size-15 ( Modified Starch) | Thailand | 32.5 | 0.63 | 20.47 |
| 3 | B-120 (Modified Starch) | Thailand | 22 | 0.68 | 14.96 |
| 4 | M01 (Binder) | France | 3 | 4.8 | 14.4 |
| 5 | M06 (Binder) | France | 0.25 | 4.8 | 1.2 |
| 6 | M12 (Binder) | France | 0.35 | 4.8 | 1.68 |
| 7 | Wax (Softener) | Thailand | 4 | 1.8 | 7.2 |
| | | | | | Total= 76.85$ |

So, the saving amount = (133.95-76.85) $

=57.1 $

## V. Discussion

From traditional recipe, if we replace CMS (Carboxy Methylated Starch) -60 with EH (Eiamheng)-15 Size and increase little amount of B (Bensize)-120, then it becomes cost effective almost at the same quality. Because of open end (OE) surface is smooth, so we can reduce 2-3kg starch from the recipe. As a result, size chemical can easily get inside into the yarn. CMS-60 is non toxic, harmless, non-irritant to skin. It’s easy for desizing, no enzymes are required, can be removed simply by hot washing under alkaline conditions.

On the other hand, EH-15 has almost similar attributes with less hardness compared to CMS. So penetration of size chemicals is easier. Most importantly, EH -15 is much cheaper than CMS-60. In total, the saving stands for = (133.95-76.855) $ =57.095$

## VI. Conclusion

In order to get better quality sized yarn, better size chemicals are required in an appropriate proportion to obtain best outcome. In this research, conventional sizing technique was examined with two different recipes on a same type of yarn, clear distinctions were identified and suggestions were made accordingly. Although starch and starch derivatives meet most of these requirements for cotton yarns, starch sizes do not provide good performance during weaving for synthetic fibers and their blends and are sometimes difficult to be desized when used on tightly woven fabrics. Further research to find better alternatives to starch, technically and commercially viable will be interesting.

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## Appendices

| | Size Chemical Costing Consumption | | | | | | |
|---|---|---|---|---|---|---|---|
| Month | Sl No | Chemical Name | Origin | Price $/KG | Monthly Used Qnty ( KG ) | Cost/Month TK | Elite% |
| Jan 2017 | 1 | Bk-2000 | Thailand | 0.78 | 9700 | 605280 | 93.43 |
| | 2 | E-5 | Germany | 0.71 | 1350 | 76680 | |
| | 3 | B-120 | Thailand | 0.68 | 2700 | 146880 | |
| | 4 | CMS-60 | Germany | 1.95 | 4950 | 772200 | |
| | 5 | T-20 | Thailand | 0.788 | 12500 | 788000 | |
| | 6 | EH Size | Thailand | 0.63 | 0 | 0 | |
| | 7 | Sizing Master | France | 4.8 | 200 | 76800 | |
| | | | China | 6.5 | 800 | 416000 | |
| | 8 | Tamsize S-250 | Indonesia | 0.443 | 4375 | 155050 | |
| | 9 | Wax( B60 ) | Thailand | 1.8 | 1875 | 270000 | |
| | TOTAL | | | | | 3306890 | |
| Feb 2017 | 1 | Bk-2000 | Thailand | 0.78 | 12450 | 776880 | 93.92 |
| | 2 | E-5 | Germany | 0.71 | 2750 | 156200 | |
| | 3 | B-120 | Thailand | 0.68 | 7200 | 391680 | |
| | 4 | CMS-60 | Germany | 1.95 | 5125 | 799500 | |
| | 5 | T-20 | Thailand | 0.788 | 8250 | 520080 | |
| | 6 | EH Size | Thailand | 0.63 | | 0 | |
| | 7 | Sizing Master | France | 4.8 | 2275 | 873600 | |
| | 8 | Tamsize S-250 | Indonesia | 0.443 | 375 | 13290 | |
| | 9 | Wax( B60 ) | Thailand | 1.8 | 1950 | 280800 | |
| | TOTAL | | | | | 3812030 | |
| Mar 2017 | 1 | Bk-2000 | Thailand | 0.78 | 12950 | 808080 | 94.78 |
| | 2 | E-5 | Germany | 0.71 | | 0 | |
| | 3 | B-120 | Thailand | 0.68 | 19950 | 1085280 | |
| | 4 | CMS-60 | Germany | 1.95 | | 0 | |
| | 5 | T-20 | Thailand | 0.788 | 3000 | 189120 | |
| | 6 | EH Size | Thailand | 0.63 | | 0 | |
| | 7 | Sizing Master | France | 4.8 | 2525 | 969600 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 8 | Tamsize S-250 | Indonesia | 0.443 | 2250 | 79740 | |
| | 9 | Wax( B60 ) | Thailand | 1.8 | 1900 | 273600 | |
| | TOTAL | | | | | 3405420 | |
| Apr 2017 | 1 | Bk-2000 | Thailand | 0.78 | 4250 | 265200 | 95.21 |
| | 2 | E-5 | Germany | 0.71 | 0 | 0 | |
| | 2 | B-120 | Thailand | 0.68 | 8825 | 480080 | |
| | 3 | CMS-60 | Germany | 1.95 | 3200 | 499200 | |
| | 4 | T-20 | Thailand | 0.788 | 17300 | 1090592 | |
| | 6 | EH Size | Thailand | 0.63 | | 0 | |
| | 6 | Sizing Master | France | 4.8 | 0 | 0 | |
| | 7 | Tamsize S-250 | Indonesia | 0.443 | 4375 | 155050 | |
| | 8 | Wax( B60 ) | Thailand | 1.8 | 1700 | 244800 | |
| | TOTAL | | | | | 2734922 | |
| May 2017 | 1 | Bk-2000 | Thailand | 0.78 | 2200 | 137280 | 95.43 |
| | 2 | E-5 | Germany | 0.71 | 0 | 0 | |
| | 2 | B-120 | Thailand | 0.68 | 5200 | 282880 | |
| | 3 | CMS-60 | Germany | 1.95 | 3300 | 514800 | |
| | 4 | T-20 | Thailand | 0.788 | 12700 | 800608 | |
| | 6 | EH Size | Thailand | 0.63 | 0 | 0 | |
| | 6 | Sizing Master | France | 4.8 | 0 | 0 | |
| | 7 | Tamsize S-250 | Indonesia | 0.443 | 3625 | 128470 | |
| | 8 | Wax( B60 ) | Thailand | 1.8 | 1175 | 169200 | |
| | TOTAL | | | | | 2033238 | |
| Jun 2017 | 1 | Bk-2000 | Thailand | 0.78 | 2050 | 127920 | 97.25 |
| | 2 | E-5 | Germany | 0.71 | 0 | 0 | |
| | 2 | B-120 | Thailand | 0.68 | 10200 | 554880 | |
| | 3 | CMS-60 | Germany | 1.95 | 1850 | 288600 | |
| | 4 | T-20 | Thailand | 0.788 | 0 | 0 | |
| | 6 | EH Size | Thailand | 0.63 | 0 | 0 | |
| | 6 | Sizing Master | France | 4.8 | 600 | 230400 | |
| | 7 | Tamsize S-250 | Indonesia | 0.443 | 1500 | 53160 | |
| | 8 | Wax | Thailand | 1.8 | 825 | 118800 | |
| | TOTAL | | | | | 1373760 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Jul 2017 | 1 | Bk-2000 | Thailand | 0.78 | 2100 | 131040 | 96.94 |
| | 2 | E-5 | Germany | 0.71 | 0 | 0 | |
| | 2 | B-120 | Thailand | 0.68 | 17975 | 977840 | |
| | 3 | CMS-60 | Germany | 1.95 | 3100 | 483600 | |
| | 4 | T-20 | Thailand | 0.788 | 0 | 0 | |
| | 6 | EH Size | Thailand | 0.63 | 0 | 0 | |
| | 6 | Sizing Master | France | 4.8 | 1675 | 643200 | |
| | 7 | Tamsize S-250 | Indonesia | 0.443 | 375 | 13290 | |
| | 8 | Wax | Thailand | 1.8 | 1250 | 180000 | |
| | 9 | E-850 | | 3.5 | 255 | 71400 | |
| | TOTAL | | | | | 2500370 | |
| Aug 2017 | 1 | Bk-2000 | Thailand | 0.78 | 3750 | 234000 | 96.57 |
| | 2 | E-5 | Germany | 0.71 | 0 | 0 | |
| | 2 | B-120 | Thailand | 0.68 | 16975 | 923440 | |
| | 3 | CMS-60 | Germany | 1.95 | 3550 | 553800 | |
| | 4 | T-20 | Thailand | 0.788 | 0 | 0 | |
| | 6 | EH Size | Thailand | 0.63 | 8150 | 410760 | |
| | 6 | Sizing Master | France | 4.8 | 2200 | 844800 | |
| | 7 | Tamsize S-250 | Indonesia | 0.443 | 125 | 4430 | |
| | 8 | Wax | Thailand | 1.8 | 2000 | 288000 | |
| | TOTAL | | | | | 3259230 | |
| Sep 2017 | 1 | Bk-2000 | Thailand | 0.78 | 5100 | 318240 | 96.83 |
| | 2 | E-5 | Germany | 0.71 | 0 | 0 | |
| | 2 | B-120 | Thailand | 0.68 | 4625 | 251600 | |
| | 3 | CMS-60 | Germany | 1.95 | 0 | 0 | |
| | 4 | T-20 | Thailand | 0.788 | 6650 | 419216 | |
| | 6 | EH Size | Thailand | 0.63 | 9025 | 454860 | |
| | 6 | Sizing Master | France | 4.8 | 1100 | 422400 | |
| | 7 | Tamsize S-250 | Indonesia | 0.443 | 750 | 26580 | |
| | 8 | Wax | Thailand | 1.8 | 1350 | 194400 | |
| | TOTAL | | | | | 2087296 | |
| Oct 2017 | 1 | Bk-2000 | Thailand | 0.78 | 6400 | 399360 | 96.11 |
| | 2 | E-5 | Germany | 0.71 | 0 | 0 | |
| | 2 | B-120 | Thailand | 0.68 | 17550 | 954720 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3 | CMS-60 | Germany | 1.95 | 0 | 0 | |
| | 4 | T-20 | Thailand | 0.788 | 9325 | 587848 | |
| | 6 | EH Size | Thailand | 0.63 | 325 | 16380 | |
| | 6 | Sizing Master | France | 4.8 | 1725 | 662400 | |
| | 7 | Tamsize S-250 | Indonesia | 0.443 | 625 | 22150 | |
| | 8 | Wax | Thailand | 1.8 | 2200 | 316800 | |
| | TOTAL | | | | | 2959658 | |
| | 1 | Bk-2000 | Thailand | 0.78 | 14150 | 882960 | |
| | 2 | E-5 | Germany | 0.71 | 0 | 0 | |
| | 2 | B-120 | Thailand | 0.68 | 22750 | 1237600 | |
| | 3 | CMS-60 | Germany | 1.95 | 0 | 0 | |
| | 4 | T-20 | Thailand | 0.788 | 1125 | 70920 | |
| | 6 | EH Size | Thailand | 0.63 | 1000 | 50400 | |
| Nov 2017 | 6 | Sizing Master | France | 4.8 | 2200 | 844800 | 94.94 |
| | 7 | Tamsize S-250 | Indonesia | 0.443 | 2500 | 88600 | |
| | 8 | Wax | Thailand | 1.8 | 3275 | 471600 | |
| | 9 | BK-1500 | Thailand | 0.77 | 2000 | 123200 | |
| | 10 | | | | | 0 | |
| | 11 | | | | | 0 | |
| | TOTAL | | | | | 3770080 | |
| | 1 | Bk-2000 | Thailand | 0.78 | 0 | 0 | |
| | 2 | E-5 | Germany | 0.71 | 0 | 0 | |
| | 2 | B-120 | Thailand | 0.68 | 18600 | 1011840 | |
| | 3 | CMS-60 | Germany | 1.95 | 0 | 0 | |
| | 4 | T-20 | Thailand | 0.788 | 0 | 0 | |
| | 6 | EH Size | Thailand | 0.63 | 12350 | 622440 | |
| Dec 2017 | 6 | Sizing Master | France | 4.8 | 1575 | 604800 | 95.22 |
| | 7 | Tamsize S-250 | Indonesia | 0.443 | 250 | 8860 | |
| | 8 | Wax | Thailand | 1.8 | 2550 | 367200 | |
| | 9 | BK-1500 | Thailand | 0.77 | 2350 | 144760 | |
| | 10 | E-850 | Thailand | 3.5 | 140 | 39200 | |
| | 11 | | | | | 0 | |
| | TOTAL | | | | | 2799100 | |