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Design of Experimental Model for the Process of Cotton Pre-Cleaning with a View to Generate Design Data

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ABSTRACT:*Cotton is the most important textile fiber in the world, The Indian cotton has relatively high level of contamination about 10-12% despite being handpicked from the farm. There are wide ranges of contaminants in cotton numbering over 20 types. The contaminant are added in different stages of processing of cotton at ginnery like during pre-ginning (46%), ginning (44%) and during pressing (10%).To reduce the contamination, it is necessary to provide the best possible technical solution at initial level of processing the cotton at ginnery. So that a good quality of yarn can be produced in textile mill and will get the realization of their produce and develop indigenous and cost effective, commercially viable technology packages. This paper reports the experimentation carried out on cotton pre-cleaner to establish the approximate generalized models for generating design data.*

Keywords**:** *Cotton Pre-Cleaner, Trash Reducer, Cotton Contamination, Pre-Ginning Processer, Trash Remover.*

I. INTRODUCTION

The Cotton is the most important textile fiber in the world; It is one of the world's most important agriculturally produced raw material. About 70% of cotton production contributed by four major countries which include China, India, USA and Pakistan. World cotton production is expected to 26.7 million MT. Out of this production India is expected to produce 5.9 million MT cotton. India has the largest cotton cultivated area and also second largest exporter after USA. Five million Indian cotton formers have made India the world's second largest producer and second largest exporter of cotton. As per the cotton contamination survey-2011 of International Textile Manufacturers Federation (ITMF) the Indian cotton has relatively high level of contamination despite being handpicked from the farm. There are wide range of contaminants in cotton numbering over 20 types.

Cotton cleaning before ginning is an important unit operation to retain quality of lint. The market value of cotton is decided by the quality and purity of its fibers. To fetch a good price in market, the baled cotton should contain minimal trash and be free from contamination [1]. The hand picked cotton initially has lower trash content as compared to mechanically harvested cotton in developed countries. If pre-cleaning is not done, trash particles will adhere to the fiber during the high pressure bailing process. Cotton is seriously contaminated with organic matter, i.e., leaves, feathers, paper, leather, etc., string and pieces of fabric made of jute/hessian, woven plastic and plastic film [4]. The other contaminants of concern, in descending order of incidence are sand, dust, grease, rust, metal wire and rubber [2]. The contaminant are added in different stages of processing of cotton at ginnery like during pre-ginning (46%), ginning (44%) and during pressing (10%).

The contaminants present in cotton are removed with the help of pre-cleaners prior to ginning operation in ginneries. Spiked cylinder and saw band type of pre-cleaners are the two well known machines used for pre-cleaning of cotton to remove contamination from cotton. The spiked cylinder pre-cleaner is mainly used for removing fine foreign matters like sand, dust, immature locks [6]. In the spiked cylinder cleaner the cylinders open up and convey the cotton scrubbing across the surface of grid bars [7]. The saw band pre-cleaner is normally used for removing for removing coarse and heavy foreign matter like stems, burrs, hulls, immature locks, stones etc. from cotton. In the saw band pre-cleaner cotton is cleaners with the help of combing action of saw[3].

Research on seed cotton cleaning equipment over the years indicates that extractors and cylinder cleaners have little influence on fiber length characteristics while positively influencing color and leaf grades. The cleaning efficiency of seed cotton cleaning equipment is influenced by many factors including initial seed cotton foreign matter content, processing rate, moisture content, machine configuration and distribution[4]. Although ginners strive for maximum production and thus tent to push the processing rate limits of their cleaning equipment, compromises must be made to balance seed cotton cleaning rate with cleaning efficiency and seed cotton loss. The excessive mechanical actions on cotton fibre in pre and post ginning process have been shown to increase the amount of neps and short fibers.

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II. NECESSITY OF GENERALIZED EXPERIMENTAL MODEL

The process of cleaning seeded cotton a complex phenomenon. In the spiked cylinder cleaner as shown in fig. 01. The cylinders open up and convey the cotton scrubbing across the surface of grid bars and remove fine foreign matters like sand, dust, immature locks through the gap between the grid bars. There are various independent and dependent variables which affects cleaning the cotton. The independent variables in the process are

i)Angular velocity of shaft- ω
ii)Diameter of cylinder- D
iii)Length of spike-L
iv)Distance between grid bar- B
v)Weight of seeded cotton- W
vi)Moisture of cotton- M
vii)Total moment of inertia of mechanical power transmission system- I
viii)Instantaneous time of Cleaning- t.

Dependent variables are

i)Weight of trash- C
ii)Time of cleaning- T
iii)Power used- P.

The objective of the this paper is to establish model by the approach proposed by Schenck Jr.[8]. As per Schenck Jr, unless all independent variable are varied over widest possible range during experimentation. Some of these independent variable could not be varied during the experimentation because of limitation of time and cost of experiment.

Figure 01: Cotton Pre-cleaner

Figure 02: Experimental Setup

Dimensional Equations

The performance of cotton pre-cleaning machine can be described as a function of several independent variables as given below.

$P = Ø \{ ω, D, L, B, W, M, I, t \}$……..(1)
$C = Ø \{ ω, D, L, B, W, M, I, t \}$……..(2)
$T = Ø \{ ω, D, L, B, W, M, I, t \}$……..(3)

Treating W, D, L and I as repetitive variables and combing them with each of the independent and dependent variable given in equation 1 to 3, carries out dimensional analysis. The dimensional equation for dependent variable have been established as detailed below.

$P/ωDW = K \{ (L/D)^c, (B/D)^d, (M)^f, (ω^2I/DW)^g, (ω/t)^h \}$……..(4)

$C/W = K \{ (L/D)^c, (B/D)^d, (M)^f, (ω^2I/DW)^g, (ω/t)^h \}$…….(5)

$TW = K \{ (L/D)^c, (B/D)^d, (M)^f, (ω^2I/DW)^g, (ω/t)^h \}$…….(6)

III. TEST PLANNING

The test envelop, test points and test sequence are decided on the basis of the known range of variation of some of the independent variables. The specific point indicates the actual values of the corresponding independent variables at the test are carried out. The sequence indicates the sequence in which the trials are conducted. The test points, test sequence and the corresponding dimensionless ratio ($\pi - terms$) are given in table 1.

Table 1: Test Planning:

Sr.	Dimensionless	Independent	Test Envelop	Test point	Test

No.	Ratio(π *terms*)	Variable			Sequence
1	π1=L/D	-	Constant	Constant	Constant
2	π2=B/D	-	Constant	Constant	Constant
3	π3=M	Moisture of Cotton	5% to 9%	5,6,7,8,9	4,2,5,3,1
4	$\pi 4=\omega^2 I/DW$	Weight of Cotton	1kg to 3 kg	1,1.5 ,2, 2.5 , 3	4,2,5,3,1
5	$\pi 5=\omega/T$	Speed	Constant	Constant	Constant

IV. TRIAL EXPERIMENTAL SETUP AND OBSERVATION

The spiked cylinder pre-cleaner consisted of four cylinders of 30mm diameter arranged horizontally and 26 spiked of 56 mm is attached to the cylinder. The spikes are welded in four rows. The power to rotate the cylinders is supplied from the 1 HP electric motors and with the help of chain sprocket arrangement. The cylinders are rotating at a speed of about 250 rpm. The top surface of the cylinders is covered with the flat metal sheets. Proper gap is maintained between the top cover sheet and tip of the spikes. The concave grids are provided underneath the cylinders. The grid is made up Ø10mm ms rod. The distance between the grid rod is kept 25mm. The trial test is conducted as per the test planning.

During the trial experimentation, the weight of cotton varies in the given range in table 1. The calibrated moisture meter used to measure the moisture of cotton. It is found to be 7%. Moisture may vary from range from 5% to 9% in final experimentation. The variation in moisture of cotton will be come out by conditioning of cotton. Accordingly the sample will be prepared. The weight of cotton required to be varied between 1kg. to 3 kg. It is measured by calibrated digital weighting machine for the trial experimentation. For final experimentation, the different weight between the ranges of moisture varied. The output variables like motor torque, Cleaning Efficiency and time of cleaning have measured and noted.

It is observed that the maximum power is utilized for transmission. The negligible power is required to clean the cotton. The cleaning efficiency is found 76%. To get higher cleaning efficiency, the distance between spike and grid should be reduce in the range 30 mm to 35 mm.

CONCLUSION

1. The cylinder type pre-cleaner was designed and developed to suit cleaning of Indian cottons. It works as cotton opener which helps to increase the efficiency of ginning.
2. The distance between spike and grid should be reducing to 25mm.
3. Maximum power is utilized for transmission. The negligible power is required to clean the cotton.
4. Need to consideration the shape of grid for redesigning.
5. No adverse effect of the pre-cleaner was observed on the fibre.

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