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Unsafe Chromium from Cotton Ginneries and Development of A Rubberized Cotton Fabric Roller for Cotton Roller Gins

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Abstract :- This paper realizes the hazards of chromium contamination and pollution caused in the use of chrome composite leather-clad (CCLC) rollers commonly used in cotton roller ginning industries and attempts to eliminate the chromium contamination and pollution during the complete process. The cotton roller ginning process is the mechanical separation of cotton fibres from their seeds by means of one or more rollers to which fibres adhere while the seeds are impeded and struck off or pulled loose. Most of the cotton ginning operations are done using roller gins. The CCLC roller coverings contain about 18 000 to 30 000 mg/kg (ppm) as total chromium of trivalent and hexavalent forms which are toxic to human health. When the seed-cotton is ginned, due to the persistent rubbing of CCLC rollers over the fixed knives, the cotton and its products get contaminated with the total chromium of trivalent and hexavalent forms. Gin and mill workers are exposed to this chromium pollution and are susceptible to health hazards since toxic effects are produced by prolonged contact with airborne or solid or liquid chromium compounds even in small quantities. The three pollutants namely cotton dust, chromium and leather powder and/or other foreign matter, under favorable conditions of sunlight (photo energy), humidity, temperature and air movement interact and produce chrome specific dust (CSD) which is a serious pollutant due to synergistic interacting function. To offset this problem, pollution-free rubberized cotton fabric (RCF) eco-friendly rollers for both the laboratory and commercial studies have been designed, fabricated and used in experiments in rollers gins. This nullifies chromium contamination and pollution during the complete process. Cotton technological parameters are well proven for commercial acceptance.

Key-Words: - chromium, cotton ,ginning, gins, pollution, rollers,

1 Introduction

Cotton, grown on the plant as seed cotton (or *kapas*) is first processed for getting separation in to lint cotton and seed in cotton ginning industries (Iyer, 1994). The principle of this roller ginning process was invented by McCarthy (Townsend et al., 1940). This process is the mechanical separation of cotton fibres from their seeds by means of one or more rollers to which fibres adhere while the seeds are impeded and struck off or pulled loose. Figure 1 shows the configuration of cotton roller ginning process. Figure 2 is the photograph of cotton roller ginning machine. CCLC rollers are employed in cotton roller ginning industries, which are subjected to tremendous wear (Iyer, 1994). Due to persistent dust-producing grinding action of CCLC rollers over fixed knives in ginning machines, CCLC rollers emit chromium in to the environment, which contaminates the cotton and its products beyond the safe limits of the eco-standards (Iyer, 2000). Since the semi-finished chrome leather washers contain 3 to 4% chromium and are being used by roller ginning industries in India, Africa, Tanzania, Egypt and China, attention has been drawn to view the contaminating and polluting aspects during the complete process (Iyer *et al.,* 2001).

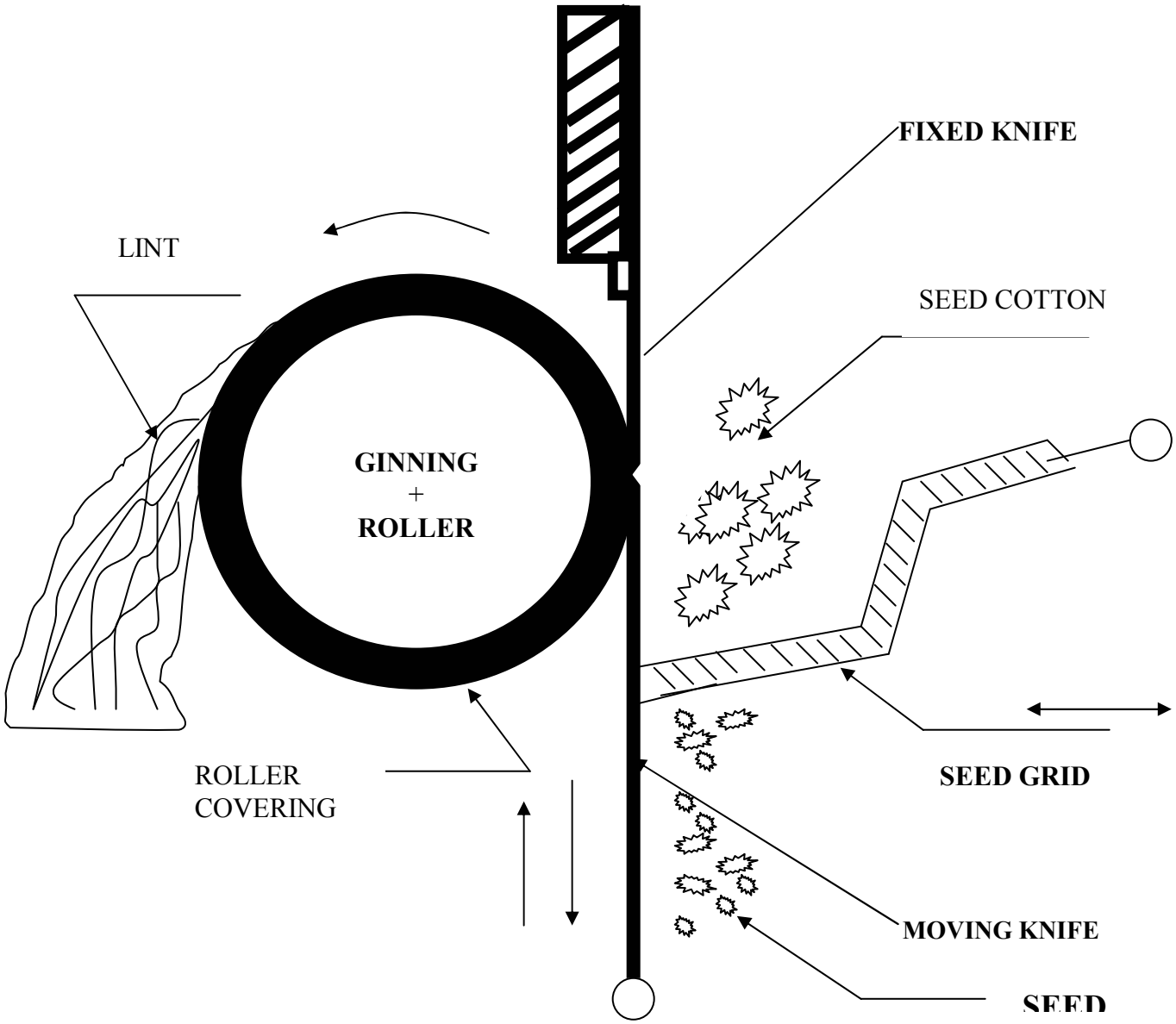

FIGURE 1 : CONFIGURATION OF COTTON ROLLER GINNING PROCESS

FIGURE 2 : CLOSEUP OF COTTON ROLLER GINNING MACHINE

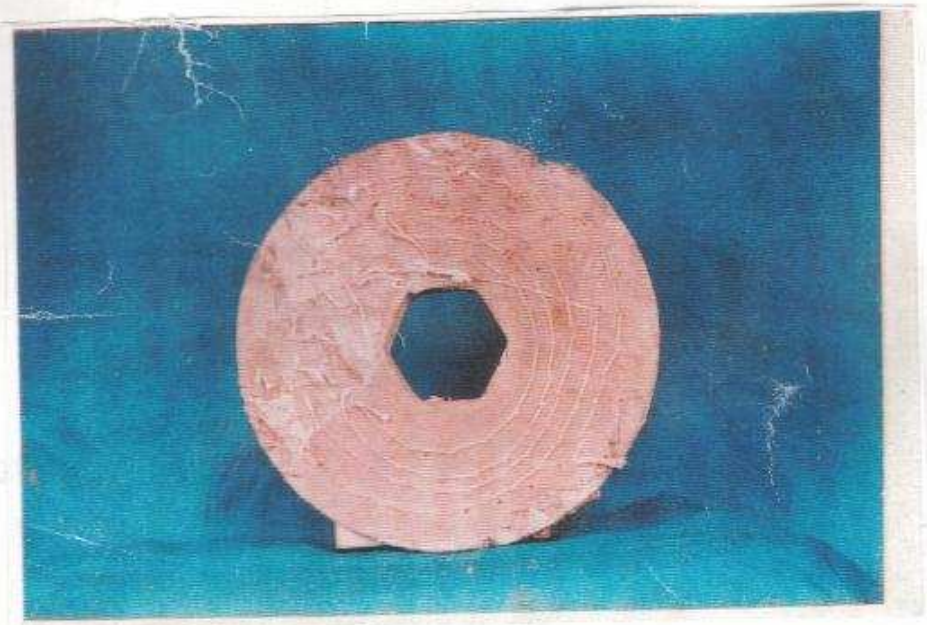

FIGURE 3 : A CHROME COMPOSITE LEATHER-CLAD WASHER FOR MAKING CCLC GIN ROLLERS

1. 1 Literature Survey

Extensive literature survey was carried out to characterize and assess contamination and pollution from the cotton roller ginning process. There was no work done elsewhere directly related to CCLC rollers which are being used in the cotton roller ginning industries. However brief outlines, which pertain to sources of chromium and health effects during the cotton roller ginning processing, were presented. The CCLC rollers have toxic and carcinogenic properties and add to the chromium burden of the environment. The dust-producing grinding CCLC rollers cause air pollution problems in the mill environment. Mill and gin workers are directly exposed to this pollution, and are vulnerable to health hazard (Iyer, 1997). CSD pollutes the gin-house air and the cotton processing workers suffer from chromium based diseases and physiological disorders. The chromium adsorbed into lint cotton causes allergic symptoms, cancer incidence, brain damage, chronic ulceration and perforation of nasal septum to cotton processing workers (Iyer, 1998). Cotton seeds get contaminated with chromium from the source. The work presented in this article is intended to identify the environmental and health related problems faced when CCLC roller are used.

2 Problem Formulation

2.1 Objectives and Need of the Present Research

The objectives of this research are (1) to identify and study the environmental and health related problems existing with the present chrome composite leather clad (CCLC) rollers employed in cotton roller ginning industries and 2) to design and develop an eco-friendly non-chrome rubberized cotton fabric roller and evaluate its performance with a particular reference to commercial and environmental aspects in cotton ginning industries.

With the author's research background and practical experience in ginning and textile industries, present study was attempted to eliminate this problem to the great extent at the source itself, through a suitable design and development of an eco-friendly, pollution-free chrome less roller for cotton roller gins. An eco-friendly roller ginning process has been developed for replacing conventional CCLC roller ginning process to eliminate the chromium contamination and pollution from cotton roller ginning industries so as to meet the requirements of environmental standards while maintaining high quality spun yarns and woven fabrics meeting the international standards.

Materials and Methods

For the present study, a roller wearing and compaction rate study were carried in roller ginning industries at Belgaum, India for the cotton seasons 1996-1997 to 1998-2000 and 2001-2002. The roller gins were adjusted using spacers as per the standards (Iyer, 1994). Grooving was done regularly at the start of each shift as per the cotton varieties. Some samples were taken randomly for the chromium analysis in mg/kg (ppm). Those samples drawn for analysis were namely lint cotton lint, seed, seed-cotton, CCLC roller, CCLC roller powder collected during grooving operation, soil, root of the plant, fibre, yarn, fabric and effluent. Atomic Absorption Spectrophotometer *(AAS)* instrument was used for total chromium analysis. AAS method followed was American Public Health Association (APHA). Respirable suspended particulate matter (RSPM) and Suspended particulate matter (SPM) concentration in gin house are monitored using *High Volume Air Sampler (HVAS)* with cascade impactor with appropriate fiber glass filters. The quantity of pollutants emitted on an eight-hour basis was collected using the HVAS and analyzed for chromium. Cotton technological parameters were tested using the instruments namely, High volume instrument (HVI) and Scanning electron microscope (SEM) for chrome roller ginned lint and eco-friendly roller ginned lint.

2.2 Environmental Impacts of CCLC Rollers

Environmental impacts of CCLC rollers are assessed from the pollutants *viz., cotton dust* and *chrome specific dust* (CSD) in the mill atmosphere. The *cotton dust* released in the ginning process is a complex and variable mixture of cotton fibres, undeveloped ovules, cotton plant debris including twigs, bract and *pericarp* particles left after the ginning process together with soil particles, bacteria, fungi and residues from pesticides (Iyer, 1990). The visible and invisible dust in the mill atmosphere is known as '*Fly'*. The ambient air particles of about 2.5 μm are classified as cotton dust in ginning environment. Byssinosis is a disease due to the inhalation of cotton dust over long period of time (Shirley Vol. II, 1982). It is a permanent disabling lung disease. The symptom is chronic cough ending in chronic bronchitis (respiratory disorder). India has a large number of ginning and textile mills employing 48% of all the factory workers (Rao, M.N., 1995). About 55% of mill workers suffer from byssinosis disease (Rao, C.S., 1995). As per the rough estimate during field survey/discussions with ginning industry management, presently, there are about 213 000 CCLC rollers, which comprise of 17 040 000 CCLC washers are used for a cotton season of three months in India. There are about 760 000 people working in roller ginning industries in India.

Chromium in CSD and contaminated cotton products acts on human in three ways such as (1) local action as dermatitis or absorption through skin, (2) direct inhalation and (3) ingestion or absorption into the stomach (Lippman, 1991). Toxic effects are produced by prolonged contact with airborne, solid or liquid chromium compounds even in small quantities because of their properties such as carcinogenecity, mutagenecity and corrosiveness (Sujana *et.al.,*1997). Complications do arise due to the reducing nature of these chromium traces that affect organic tissues of body.

The air pollution due to CSD and cotton dust, which was responsible for synergistic (augmentative) health complications of chromium based diseases and byssinosis diseases on ginning industry workers (Iyer, 2001). Indian spinning and ginning mills are not provided with dust control systems for the workers. It is mentioned that the ginning industries are located in and around cotton growing areas and employ women in the age group of 21 to 40 years for menial jobs and male workers in the age group of 18 to 50 years. The women often come along with their children for performing their jobs, like (i) feeding seed-cotton (or *kapas*), (ii) collecting the lint cotton, seed and floor sweeping, (iii) cleaning and grading the seed-cotton and (iv) light activities. The children are exposed directly to CSD. The health effects and reports of the workers have not come out into public, because (i) almost all the workers are not in regular employment, (ii) the cotton ginning industry functions seasonally for 6-8 months in semi-arid zones and 8-10 months in rain fed areas in an year, (iii) the workers are reluctant to go for their medical checkup because of their negligence and fear and (iv) they are economically not sound enough to go for their medical treatments.

2.3 Description and Performance of CCLC Rollers in DR gins

The roller is the major component of double roller (DR) gin (Iyer,1993). The gin roller length varies from 1025 to 1148 mm with a outside diameter varying from 178 to 180 mm suitable for operation. The roller consists of 78 to 80 numbers washer disks. Thickness of the each washer disk is 18 mm. Each washer disc is made of 18 flaps stitched and bonded together having the diameter 180 mm and each flap thickness of 1 mm (Iyer, 1997). Figure 3 shows chrome composite leather washer for making CCLC roller gins. Figure 4 is an engineering drawing of the cladding of chrome composite leather clad washers comprising of roller of a double roller ginning machine. Basic chromium sulphate (BCS) Cr (OH) SO_4 nH_2O and impure chromate having 45-50 % basicity are used during the chrome leather tanning process for making such CCLC flaps (Iyer, 1998).

The various unit operations involved in making washers to the usable roller were (i) The washers mounted on a steel shaft having square cross section of 50 mm^2 or hexagonal section of 50 mm End to End to form a roller, (ii) The mounted washers are compressed to a pressure of 2 Pascal by using a conventional pressing machine. The roller was to be pressed on both sides by adding required number of washers on each side, (iii) The pressed roller was turned and finished to a outside diameter of 180 mm in a center lathe, (iv) Spiral grooves are made on the surface of the finished rollers. The finished roller is ready for the grooving operation by using band saw; initially by marking 'U'-shaped spiral grooves, fixing in the grooving machine and lastly spiral grooves are made on the roller surface by a band saw or circular saw cutting machine (Iyer, 1996).

The ginning efficiency primarily depends upon the surface speed of the roller and the number of working strokes on the moving knife (Shete *et.al.,* 1993). When the rollers are used in the ginning machines, the rate of ginning decreases as the roller diameter decreases. The roller outside diameter was reduced to 114 mm at the end of the cotton season. The reduction in diameter was directly proportional to the quantity of seed-cotton ginned (Iyer, 1999). After possible usage, the washers were removed from the shaft. Again the new washers were recovered and mounted in the shaft. The worn out and consumed washer disks were discarded after considerable period of usage having two to three months. A health study was carried by the author at Guntur, Bailhongal, Sendwa,

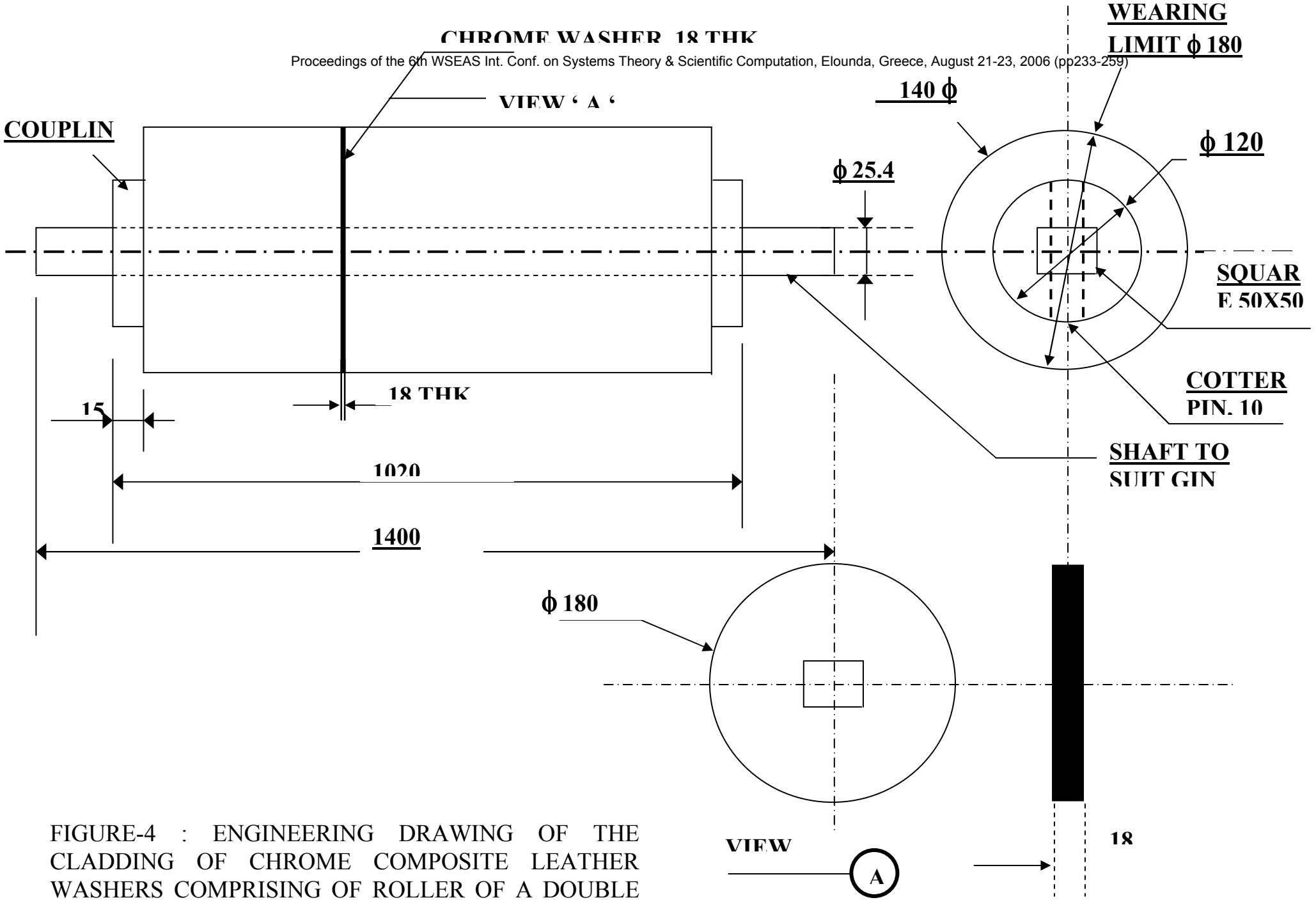

FIGURE-4 : ENGINEERING DRAWING OF THE CLADDING OF CHROME COMPOSITE LEATHER WASHERS COMPRISING OF ROLLER OF A DOUBLE ROLLER GINNING MACHINE

ALL DIMENSIONS ARE MILLIMETER

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Surendranagar, India, Tanzania and China, where maximum number of ginning factories are situated to survey the health effects and occupational health hazards. A suitable eco-friendly roller ginning process can eliminate this unsafe chromium contamination and pollution in the environment (Iyer, 1998). Therefore an exhaustive study was undertaken for the design and development of eco-friendly non chrome RCF rollers for modifying the existing conventional CCLC rollers.

3 Problem Solution

3. 1 Basis for the Design of Eco-friendly Rollers

Engineering material studies were done for the suitable material's selection of the gin rollers which were made of Walrus animal skin, Spider tuck packing, coir, rubber packing, metal cylinder, rubber roll, fabric and rubber packing, leather, cotton, rubber and cork, plastics and fluorinated ethylene propylene (Iyer,1997). The peculiar gripping action or adherence of the cotton fibres to the roller surface was considered while designing the rollers. The leather surfaces possess interfibrillary action, which adheres the fibre on the surface the roller surface (Iyer, 2002). This particular property was studied extensively for the different materials and combination of different materials so as to design and fabricate laboratory gin chrome less rollers for gin roller experimentation device (GRED) and prototype eco-friendly chrome less rollers for existing DR gins. The objectives of laboratory studies were to define the physical properties of a roller covering material which contributes to its energy consumption, ginning rate potential, eco-friendly parameters, cotton technological parameters, mechanical engineering analysis, wear resistance properties, heat proof capacity and to search better roller covering materials.

3.2 Materials and Methods

The ginning investigations were carried out at Central Institute for Research on Cotton Technology (CIRCOT), Mumbai. The laboratory rollers for GRED were designed and fabricated at Calcutta in a local manufacturing firm. Figure 5 is the close up photograph of gin roller experimentation device (GRED). Experiments with the designed rollers were carried at CIRCOT, Mumbai, India along with the cotton technological parameters. After the initial tests, the pilot model rollers were designed, fabricated and tested in ginning factories located at Bailhongal and Sendhwa, India. Figure 6 is the assembly drawing of rubberized cotton fabric (RCF) washers for making RCF rollers of cotton double roller gins. Environmental analysis was done in Centre of Mining Environment, Indian School of Mines, Dhanbad, India and Eco-Textile laboratory, Mumbai, India. Mechanical properties were analyzed in various mechanical engineering laboratories. A Pilot model 'System after Modification' was demonstrated in a ginning industry at Bailhongal, India. Figure 7 is the closeup photograph of double roller ginning machine mounted with RCF rollers.

3.3 Results and Discussions

An experiment was carried to find out the wearing and compactness rate of CCLC rollers used by roller ginning industries for a season lasting three months. At the start of season the diameter of rollers were 180 mm. At the end of season the roller dimensions were noted at left, middle and right positions for all the roller gins in the factory that is 18 ginning machines. Roller side “A” was the front side of the gin. Roller side “B” was the rear side of the DR gin. The results are presented in Table 1. Apart from the wear rate, the table expresses the quantity of pollutants generating during the operation such as, leather powder, cotton dust and chrome specific dust. It was found that the wearing rate was 0.033 mm / hour and the percentage material removed per roller was 43.8%. The final outside diameter at the end of study was nearing to 140mm. Chromium roller compaction rate was 0.050 mm/hour that is 50 μm / hour.

Figure 8 depicts a graph of wearing rate of dust-producing grinding of CCLC roller and RCF roller.

Chromium analysis reports of cotton lint samples, seed and seed linter, seed-cotton samples, fiber, yarn and fabric samples were tabulated in Table 2. The CCLC roller contains 18 077 mg/kg (ppm) to 30 780 mg/kg (ppm) as total chromium (3 to 4% as total chromium). This included trivalent and hexavalent chromium. During the ginning operation, lint adsorbs chromium particles, which

FIGURE 5 : CLOSE UP OF GIN ROLLER EXPERIMENTATION DEVICE (GRED)

contains 143 mg/kg (ppm) to 1994 mg/kg (ppm). Chromium concentration in dust samples, SPM and RSPM of different ranges are provided in Table 3. The CCLC roller was grooved at the start of each shift and filing or turning of the roller for leveling was done to get a uniform diameter at the start of each season. At that time, the chromium content in the lint cotton was 1994 mg/kg (ppm). The total weight of chromium removed during a cotton season of 16 hours per day was 450 to 600 grams per gin roller. The chrome specific dust from one ginning machine entered the environment to the level of 143 ppm. The environmental standards for chromium in spun yarn are 2 ppm and Cr (III) for baby clothing and fabric is 0.1 ppm and nil for Cr (VI). The traces found contain hexavalent chromium being adsorbed from contaminated lint, yarn to fabrics and subsequently cannot be removed in fabrics. There is evidence that the toxic effects on humans due to Cr (III) and Cr (VI) of its carcinogenecity and corrosiveness. The analysis shows that traces of Cr (VI) are found in even laboratory grade trivalent chromium compounds and complications do arise due to the reducibility nature of these traces that affect the organic tissues of the body. These regenerating effects occur rapidly and depend on the worker dose and exposure time.

Table 1. Roller wear results for rollers with initial diameters of 180 mm

Machine Number	Outside Diameter of the Rollers After One Cotton Season(mm)*					
	Roller Side 'A' is the Front Side of the Machine			Roller Side 'B' is the Rear Side of the Machine		
	Left	Middle	Right	Left	Middle	Right
1	140	140	140	141	143	142
2	140	140	140	140	142	142
3	145	146	150	150	145	140
4	153	153	153	148	148	148
5	148	147	148	148	148	148
6	146	147	148	146	146	146
7	135	135	135	145	142	140
8	140	140	140	145	142	140
9	150	150	150	148	148	148
10	138	136	136	136	136	136
11	145	145	146	145	145	145
12	136	136	136	136	136	136
13	158	158	158	158	157	157
14	160	160	160	161	160	160
15	154	154	154	155	156	156
16	155	155	156	155	154	154
17	160	160	159	160	160	160
18	160	160	161	160	161	166

*Initial diameter of the rollers = 180 mm .

Table 2 . Chromium Contamination levels in cotton and its products

Cotton and its Products	Total Chromium	Eco-Standards*
Lint cotton	143-1990 ppm	0.1 ppm
Spun yarns	17- 250 ppm	0.1 ppm
Woven fabrics	17- 45 ppm	0.1 ppm
Cotton seeds	0-312 ppm	2 ppm
Edible oil	0-259 ppm	2 ppm
Oil cake	0-190 ppm	2 ppm
Linter	0-159 ppm	0.1 ppm

*Environmental Standards as per Ministry of Environment and Forests (1996)

Following were the significant findings of chromium in dust samples with relevant eco-standards

Table 3 : Chromium level in dust samples

Sources of Cotton dust	Total chromium	Standards* LD_{50}
Ginning point	51-173 ppm	50 ppm
CCLC grooving point	17-1994 ppm	50 ppm
Respirable Suspended Particulate Matter (RSPM) Below 1 microns	51-190 ppm	50 ppm
RSPM 1 to 3 microns	119-142 ppm	50 ppm
RSPM 3 to 5 microns	103- 295 ppm	50 ppm
RSPM 5 to 7 microns	56-152 ppm	50 ppm
RSPM 7 to 10 microns	52-133 ppm	50 ppm
Suspended Particulate Matter (SPM) in Gin House Air	159 ppm	50 ppm

*U.S. National Institute of Occupational and Safety Hazard Standards (1992)

The roller constitutes an important element of roller gins. Until 1940, only Walrus animal hide was used as roller covering material in USA and UK. Later on due to the non-availability of Walrus, these countries did not allow this type of hides to be used and obsolete these roller gins. Sheep and Buffalo chrome tanned hides, were used as substitutes in the roller ginning machines, though the interfibrillary action is not satisfactory compared to walrus hides. The roller materials *viz.,* ordinary leather, newspaper, corkboard, and coconut coir were also tried, but have not been found suitable. Since 1940, chrome composite leather-cladding (CCLC) material has been under use for making rollers of roller gins till now in India, China, Africa and Egypt. The CCLC rollers have not been used in USA and UK, since many years. To offset this serious problems of chromium contamination and

pollution caused by CCLC rollers from cotton ginning industries used in India, Africa , China and Egypt, some types of chrome-free rubberized cotton fabric (RCF) rollers both for laboratory and commercial studies have been designed, fabricated and experimented on a special laboratory-built gin roller experimentation device (GRED) and double roller (DR) gins. Some of the physical properties for better roller covering materials have been studied such as energy consumption, ginning rate potential, eco-friendly parameters, cotton technological parameters, mechanical engineering analysis and wear resistance properties. The laboratory studies revealed that the rubberized cotton fabric (RCF) roller was the most suitable one. Hence, RCF rollers were covered with packing-type roller covering material made from multiple layers of cotton fabric bonded together with rubber compound. Given below the details of the materials used in rubber compounding for the manufacture of RCF rollers.

3.3.1 Materials for rubber compounding (Indian Standards Code-3400)

Natural rubber = 100 Unit
Zinc oxide = 10 Unit
Stearic acid = 2 Unit
Accelerator = 1 Unit
Anti-oxidant (non-staining agent) = 1 Unit
Processing oil = 10 Unit
White filler = 40 Unit
Titanium dioxide = 10 Unit
Sulphur = 2.5 Unit
Resin = 20 Unit

Rubber compounding (Rubber Board, India)

Natural Rubber = 100 unit
ZnO = 5.0 unit
Stearic Acid = 2.0 unit
S.P (Processing oil) = 1.0 unit
Silica (ppt) = 25.0 unit
Whiting = 20.0 unit
Clay = 50.0 unit
Al. Silicate = 25.0 unit
Wooden resin = 5.0 unit
TiO_2 = 5.0 unit
CBS (accelerator) = 1.0 unit
Sulphur = 2.5 unit

Seven types of roller covering materials with different rubber compounding and multiple fabrics composition were tested in GRED and DR gins. Two rollers were abandoned primarily due to higher wear, adhesive failure and ginning was not carried out properly. One of this type RCF roller was found to be successful in ginning out the seed-cotton, while maintaining high ginning rate potential, cotton technological parameters of lint, yarn and fabric properties.

The RCF rollers made with this type of experimental covering materials were tested (1) to find obvious shortcomings in performance such as short roller life, wear rate, temperature and lint contamination, (2) to establish the existence of some ginning rate potential. Five RCF rollers were found effective and successful in ginning out seed-cotton. One of the specimens of the fabrics and rubber packing-type gin roller covering material was superior to all types tested in ginning rate potential (kg of cotton ginned per unit time at maximum feed rate) and in amount of energy consumed (work required to gin a kg of lint). Due to friction between roller and stationary knife, the temperature of this roller was increased upto 55 °C, which facilitate rapid ginning operation. The manufacturing technology, design engineering features and assembly

drawings show that the conventional fabric and rubber roller gin covering material was selected with the following characteristics:
Hardness of 90 (type DO durometer),
9 to 10 layers of fabrics 20 mm length,
Thickness of fabrics 1.2 mm,
The rubber compounding is resilient and
0 .76 mm of fibre bristle protrudes beyond the rubber surface in spite of wear.
On the basis of the design and development of various rollers with subsequent performance evaluation studies, a chrome-free RCF roller has been demonstrated in ginning industries. The newly developed RCF rollers were successful and effective in functioning and in ginning out the seed-cotton. An economical cost analysis revealed that eco-friendly RCF roller ginnery found better in all aspects with reference to environmental, cotton technological and commercial aspects. This improved technology was amenable for commercialization to the industries. Given below the Table 4 showing data of engineering analysis of eco-friendly lint cotton and chromium contaminated lint cotton. Given below the Table 5 and 6 showing data of cotton technological parameters of eco-friendly lint cotton and chromium contaminated lint cotton.

Table 4. Data of engineering analysis of eco-friendly lint and chromium contaminated lint

PARTICULARS	ECO-FRIENDLY GIN ROLLER/GINNED LINT	CHROME GIN ROLLER / GINNED LINT
Seed Index	7.07	7.34
Knife blunting	Every four days	daily
Grooving of gin roller frequency period	Every five days	daily
Power at No load, 400 V	1.28 kW	1.6 kW
Power at Full load, 400V	1.696 kW	1.92kW
No load current	4A	5 A
Full load current	5.3A	6 A
Seed fuzz	6.2%	5.0%
Diameter reduction per machine-hour	37.89 μm	64 μm
Production per machine-hour	38.26 kg	36 kg
Expected useful life of washer (wearing up to 30000 μm)	844 Machine-hour	437.5 Machine-hour
Coefficient of Friction of lint cotton on roller	0.768	0.123

Table 5. High volume tests using high volume instrument (HVI) and scanning electron microscope (SEM) for cotton technological properties

PARTICULARS	ECO-FRIENDLY GIN ROLLER/GINNED LINT	CHROME GIN ROLLER / GINNED LINT
2.5% Span length	27.7	28.6
Tenacity, g/tex	21.3 g/tex	22.2 g/tex
Uniformity Ratio, UR%	46	45
Short Fibres,%	3.5%	4.0%
Color/grade/appearances	Yellowish and Very good	White shining, poor
Wax content proportion	0.3% and better dye Catching properties	Nil Poor dye Catch properties
Dye up-take	Very good	Poor
Scanning physical and chemical properties	Very good	Poor
2.5% span length, mm	35.6	35.4
Uniformity, %	46.0	44.0
Baer sorter, Mean length,mm	32.3	32.8
Elongation	40.0	42.0
Short fibre, %	14.6	16.4
Tenacity, g/tex	28.6	27.8
Micronaire	3.0	2.8
2.5% Span length,mm	28.5	28.2
Uniformity Ratio, %	47.0	47.2

Table 6. Fiber and dye catch properties

PARTICULARS	ECO-FRIENDLY GIN ROLLER/GINNED LINT	CHROME GIN ROLLER / GINNED LINT
Short fibre, %	6.2	5.2
Tenacity, g/tex (1/8 ”stello gauge)	21.8	21.4
Elongation	6.0	5.7
Micronaire	3.4	3.3
Leaf	3.0	4.0
Area ,%	0.60	0.7
Trash Count	28	28
Rd	67.7	67.8
+b	14.5	14.5
Color Grade	24.4	24.4

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FIGURE 6: ASSEMBLY DRAWING OF RUBBERIZED COTTON FABRIC (RCF) WASHERS FOR MAKING RCF ROLLERS OF DOUBLE ROLLER GINS

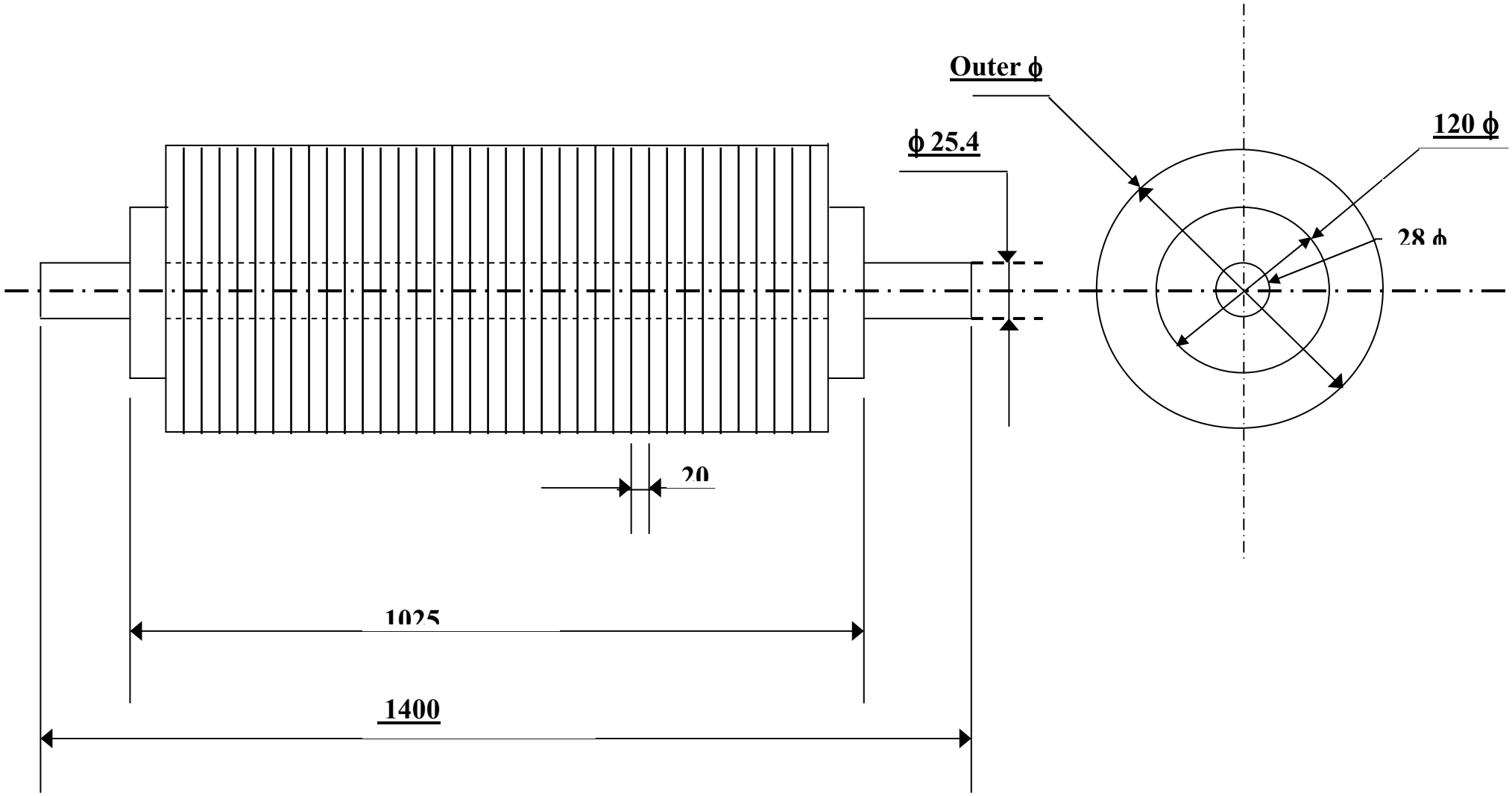

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FIGURE 7 : CLOSEUP OF DOUBLE ROLLER GINNING MACHINE MOUNTED WITH RUBBERIZED COTTON FABRIC ROLLERS

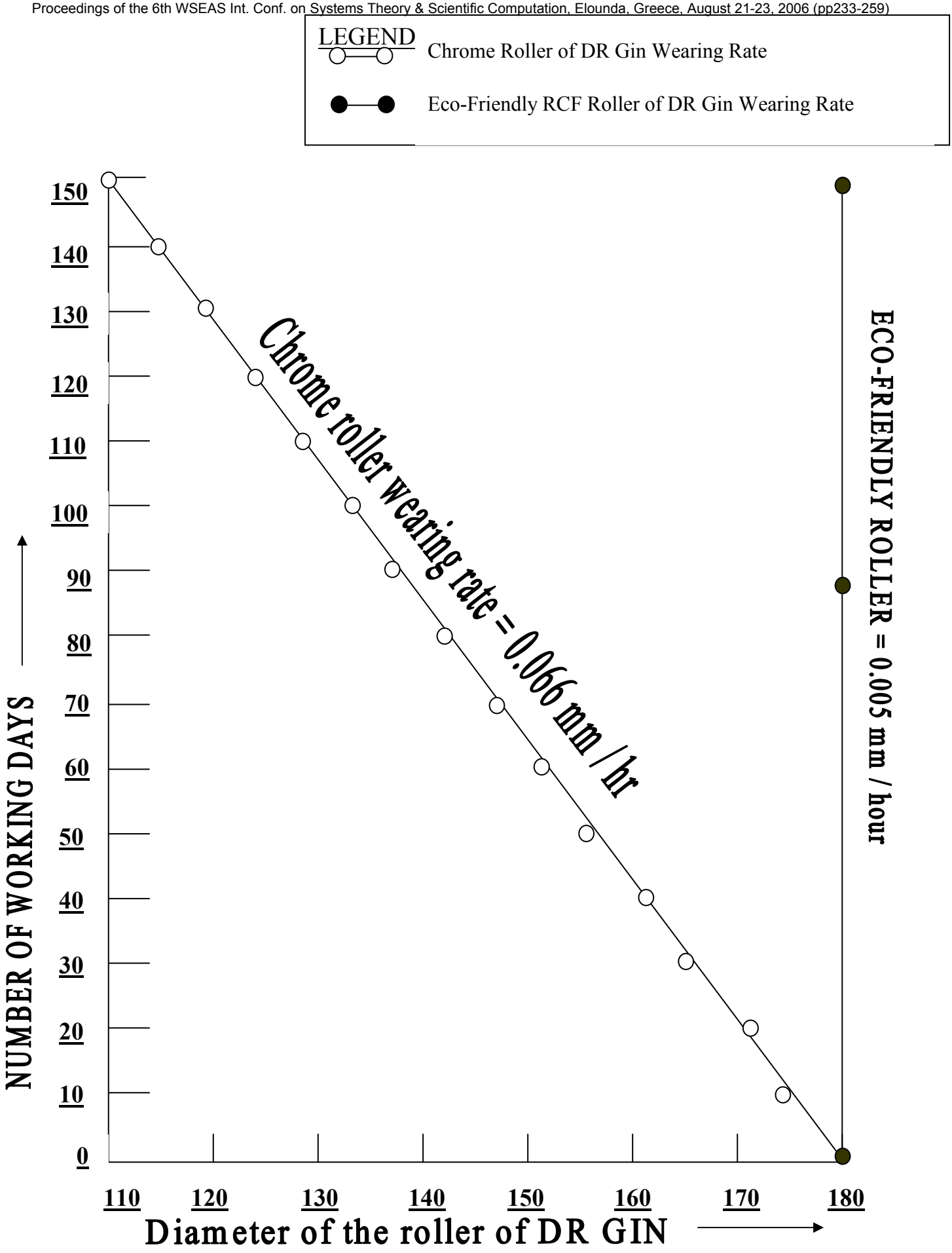

FIGURE 8 : A GRAPH OF WEARING RATE OF DUST – PRODUCING GRINDING OF CHROME ROLLER AND ECO – FRIENDLY

4 Conclusions

The CCLC rollers used in ginning industries get powdered during ginning operation and entered the environment as CSD. The CSD has been found to contaminate cotton and its products. The chromium contamination levels for cotton and its products were high for all the samples except the cotton samples obtained from RCF roller gin rollers from eco-friendly ginning industries. As per the eco-standards, chromium content in cotton and its products should not be more than 0.1 ppm for Cr (III) and Zero for Cr (VI). The samples, namely, lint cotton, yarn, fabrics, seed, linter, edible oil and oil cake were found contaminated and their levels were in the range of 110 to 1990 ppm obtained from the source of dust-producing grinding CCLC rollers sample which contained 18 077 to 30 783 ppm. The ginned lint cotton got contaminated to an extent of 143 to 1990 mg/kg (ppm) of chromium and the woven fabrics to the tune of 17 to 45 ppm of chromium against the safe limit of 0.1 ppm. SPM and RSPM chromium concentration were within the range of 50 to 190 ppm. Gin and mill workers were exposed to this chromium pollution and were susceptible to health hazards since toxic effects are produced by prolonged contact with airborne or solid or liquid chromium compounds even in small quantities.

To avert this unsafe chromium contamination and pollution from cotton ginning industries, eco-friendly alternatives have been designed and developed for laboratory analysis and commercial production. On the basis of the design and development of various rollers with subsequent performance evaluation studies, a chrome-free RCF roller has been demonstrated in ginning industries. The newly developed RCF rollers were successful and effective in functioning and in ginning out the seed-cotton. An economic analysis revealed that eco-friendly RCF roller ginnery found better in all aspects with reference to environmental, cotton technological and commercial aspects. This improved technology is amenable for commercialization into the industries.

The Mean Time Between Failure (MTBF) of the RCF roller is 11 times more than the MTBF of CCLC roller, the high price is compensated, as it is durable upto an estimated life of seven years than more of a few months of CCLC rollers. Besides, it ensures the following advantages.

Roller requires less maintenance care, since, there is a little wear rate

(2) High ginning efficiency and output of about 1.25 times more than the CCLC rollers because the developed roller made up of rubberized cotton fabrics has a surface finish conducive to high ginning efficiency,

(3) Power saving of one third compared to CCLC roller ginneries due to 50 % reduction in weight of the rollers.

(4) It is observed that the noise level in eco-friendly ginneries is reduced to a range of 4 to 7 dB (A) due to inherent properties and cushioning effects,

(5) Eco-friendly cotton and its products can be obtained.

(6) Labor output / hr is 240 % more, that is two times productivity of CCLC ginneries because of the cleaner environment.

(7) Medical charges for treating the affected workers decrease on tenth compared to CCLC ginneries.

The newly designed and developed eco-friendly ginneries eliminate chromium contamination and pollution from cotton ginning industries. These give rise to control at-source pollution control, such that the industries meet the requirement of environmental standards being enforced by many countries and high quality yarns and fabrics meeting international standards be produced. The industries will be free from chrome-related contamination and pollution problems, occupational and non-occupational health hazards. The ginneries have been tested commercially and found better in all aspects with reference to cotton technological parameters, dye-catching properties, physical and chemical properties. It could be successfully used commercially as an improved alternative in cotton ginning

industries for clean environment with benefits to society, industry owners, cotton merchants, workers, employees and the Government.

Recommendations

Most of the cotton ginning operations are done by using DR gins in India, Africa, China, Tanzania and Egypt. Out of the lint cotton obtained from CCLC roller ginneries in these countries, it is quite important to appreciate the fact that the lint cotton so produced is contaminated with chromium heavy metal which produces deleterious effect on the people working in the vicinity. Yarn and seed obtained are also contaminated with chromium. Hence it is imperative that a policy decision must be taken to replace the presently used CCLC rollers with eco-friendly rollers designed and developed in this research project.

2. Industry, Government and Regulators should come forward to subsidize this venture in view of its demonstrated technology.
3. Urgent steps are required to be taken by the National and international Government Regulatory authorities for transfer of this innovative technology to cotton ginning industries and thus save environment from unsafe chromium contamination and pollution.

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