A High-Efficiency Method of Fiber Opening andCotton Trash Removal

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ABSTRACT

Cotton trash plays an important role on determining yarn quality. The mechanism of fiber opening and cleaning is the key technique to remove trash from raw material. In this study, a multi-fiber opening, including pre-, coarse-, fine- and microfine-opening was designed and a high-voltage static-electricity equipment combined with air suction was applied to improve fiber opening and trash removal. The results show that the percentage of trash removal is increased by 40-50% and nep increase of the processed cotton is only 30-50%, which is advantageous in producing a good-quality yarn.

Introduction

Cotton is one of most important fibers used for textiles, accounting for nearly 50% of the world fiber consumption during last decades. Compared to synthetic fibers, cotton bales contain more foreign matters such as seed coat fragments leaf trash and dust. Consedquently, a different opening and cleaning process is needed to deal with natural fibers. Many machine designs have been developed and used in commercial textile mills to clean and open raw cotton and produce good quality yarn,

More modifications and developments in machine manufacture are still being implemented to improve the efficiency of fiber opening and trash removal to meet the requirement of fiber opening and cleaning. In general, however, fiber damage and nep formation is increased with increasing fiber opening by aggressive opening of conventional machine. A gentle but intensive fiber opening system that provides a fiber opening without severe fiber damage, is required by machine manufacturers or spinners. This paper discusses a new design of fiber opening and cleaning that gives a higher degree of trash removal and a lower degree of nep formation.

Experimental

Basic design of fiber opening

In conventional cotton spinning process, fiber opening in the blowroom is processed in two steps, coarse and fine opening that may use beater cylinders with different types of pins or sawtooth wires. These high-speed beaters take off cotton tufts and knock out trash and open up the cotton mass. Due to the impact of these beaters on fiber tufts, single fibers are damaged or broken. In this study, a system consisting of pre-, coarse-, fine- and microfine- steps were designed to open raw cotton in a non-impact way.

Pre-opening of fiber tufts

Fiber flow comes from a mixer or opener and fiber tufts are stored in the fiber chamber (Figure 1). A pair of feed rollers covered by a sawtooth wire are set to feed the fiber lap into the first beater cylinder. Pre-opening of fiber tufts is achieved by feed rollers with different surface speeds that provide a gentle draft force that breaks up fiber tufts. Since the pre-opening has no nipping point, low fiber stress and no nep formation are achieved.

Coarse and fine opening of fiber tufts

Three beater cylinders are selected and machined to carry out fiber opening after pre-opening fiber tufts. The first beater cylinder is covered by a number of pins (or spikes) with a length of 20mm and a diameter of 2mm that have a good fiber opening function but lower fiber damage. A set of adjustable grid knives and air suction is used to remove trash during fiber opening. This process is called coarse opening.

After passing the coarse fiber opening section, fiber flow comes to second and third beater cylinders, the former has the same diameter of 200 mm as the first beater cylinder but is covered by sawtooth wire that provides intensive fiber opening. Adjustable grid knives and air suction surround the beater cylinders.

The last cylinder has a large diameter of 400 mm and covered by finer sawtooth wire. It has a higher surface speed and gives fiber tufts a draw force and tears them into small fiber tufts. These beaters give the fiber lap a finer opening.

In order to get a smooth fiber transfer between the second and third beater cylinders, there is a stripping roller between these beater cylinders. This protects fiber tufts from nep formation.

Microfine- opening of fiber tufts

During passage through the beater cylinders, a certain degree of seed coat and trash is removed and fiber tufts become very loose. A special device providing an static-electricity field next to the third beater removes short fibers and dust.

Fiber flow leads to a channel formed between two copper plates with a gauge of 100-120 mm (Figure 1). These copper plates have a number of small holes with a diameter of 6 mm, leading to a suction fan. In addition, they are connected to a power supply with a maximum high voltage of 60,000. A static field is formed between the plates that gives fiber tufts a soft (non-machanic impact) drawing force to open them. Combined with air suction, short fibers or dust in the fiber flow are removed through the holes in the copper plates. This is called microfine- opening.

Material used and processes applied

Material used

Two trials were conducted in the research laboratory and a local mill. Different cotton blends were used for these trials (Tables 1 and 2).

Processes applied

A) In the laboratory process

Bale opener → mono-beater cleaner → Mixer → **HVEO** → DE DUST→ Chute feed → Carding

B) In the local mill process

Bale opener → premixer →Mixer →**HVEO**→ DE DUST→ Chute feed → Carding

* HVEO: High voltage electricity opener

Quality Testing

A) FCT (Fiber Contamination Tester)

B) AFIS(Advance Fiber Information System)

C) MDTA 3

Samples were collected before and after the HEVO machine. There are three tests for MDTA3 testing, five tests for AFIS, and 10 tests for FCT. An average value of these tests for each sample was calculated.

Results and Discussion

Laboratory testing

In the beginning, a pilot plant was set in the blowroom line that gave a full production of 150 kg/hr. Two types of raw cottons with a trash content of 3.8% were blended manually in a ratio of 50/50 China/India raw cotton before feeding to the bale opener. Different samples were tested and the results compared (Tables 3 and 4).

Clearly, MDTA3 testing shows that the percentage of trash removal (including trash and dust) of the HVEO machine for the blend material is about 45%. The AFIS test shows the fiber length increased is 2%, neps increased by 28% and short fiber content decreased by 40% during processed by the HVEO machine. In addition, FCT tests showed neps increased by 40%, seed coat fragment by 32% and trash decreased by 16% in number. This suggests that total trash of the blend cotton is greatly reduced but neps and seed coat fragment increased in number during the opening and cleaning process.

Mill testing

A copy machine was installed in a blowroom line for producing semi-combed cotton yarn in a local spinning mill. The full production of the blowroom in spinning process was about 700 kg/hr. Samples from the blended cotton with a trash content of 2.7% were collected and tested by the same testing equipment (Tables 5 and 6).

These test results show the same trends as the laboratory tests. MDTA3 tests show that the percentage of trash removal is about 39%. The AFIS test shows an increase of about 41% in neps and 3% in fiber length with a decrease of 25% in short fiber content. FCT tests showed an increase of about 48% in neps and 39% in seed coat fragments. FCT tests showed an increase of 48% in the number of neps per gram, 39% in the number of seed coat fragments and 35% in number of trash particles.

Compared to the results from the laboratory the increase in neps in the mill test was higher. The reason for this is may be differences in beater speeds. The first beater cylinder speed was 800 rpm for laboratory tests and 1000 rpm for mill tests. The percentage of trash removal was lower in the mill trial. This may be caused by different trash content of the blend materials (3.8% for laboratory tests and 2.7% for mill test). The higher the trash content of raw cotton, the greater the cleaning efficiency. The HVEO is very effective in removing short fiber. This would change by 40-50% if the device does not have electrostatic power and air suction switched on.

Conclusion

1. The results confirm the gentle but intensive fiber opening and cleaning for which the opener containing pre-, coarse-, fine- and microfine- opening stages were designed.

2. The percentage of trash removal is about 39- 45% in the MDTA3 test.

3. Fiber length is increased 2-3%, short fiber content decreased 25-40% and neps are increased about 28-41% in AFIS tests.

4. Neps are increased by about 40-48%, seed coat fragment by about 32-39% and trash 16-35% in number in the FCT test.

5. The effect of HVEO on short fiber content is significant and the change in the percentage of removal of short fiber content is 40-50% with the electrostatic power and suction switched on.

Table 1. The blend cotton used in research laboratory testing.

Types	Length (mm)	Micronaire	Strength	Rd	+b
China/India 50/50	36	3.9	90	77	9.0

Table 2. The blend cotton used in mill testing.

Types	Length (mm)	Micronaire	Strength	Rd	+b
Manbo/S	36	3.9	90	77	9.0
SWAN	36	4.1	93	80.4	8.8
Manbo	36	3.7	91	76.6	9.3
ALTO	35	4.3	94	73.1	9.6
Manbo	36	3.7	90	76.5	9.3
ALTO	35	4.1	93	74.9	9.3
Average	36	4.0	92	75.6	9.3

Table 3. The laboratory testing results before HVEO.

	Trash	Dust	Seed coat F	Neps
MDTA3	3.4%	0.1%	0.3%	-
AFIS	-	-	-	246
AFIS	Fiber length =24.92mm		SFC=7.03%	
FCT	67	-	78	98

FCT : No. /g SFC = short fiber content

Table 4. The laboratory testing results after HVEO.

	Trash	Dust	Seed coat F	Neps
MDTA3	1.9%	0.08%	0.1%	-
AFIS	-	-	-	315
AFIS	Fiber length =25.37mm		SFC=4.20%	
FCT	56	-	103	120

FCT : No./g SFC = short fiber content

Table 5. The mill testing results before HVEO.

	Trash	Dust	Seed coat F	Neps
MDTA3	2.4%	0.1%	0.2%	-
AFIS	-	-	-	248
AFIS	Fiber length= 28.4mm		SFC = 8.5%	
FCT	51	-	58	135

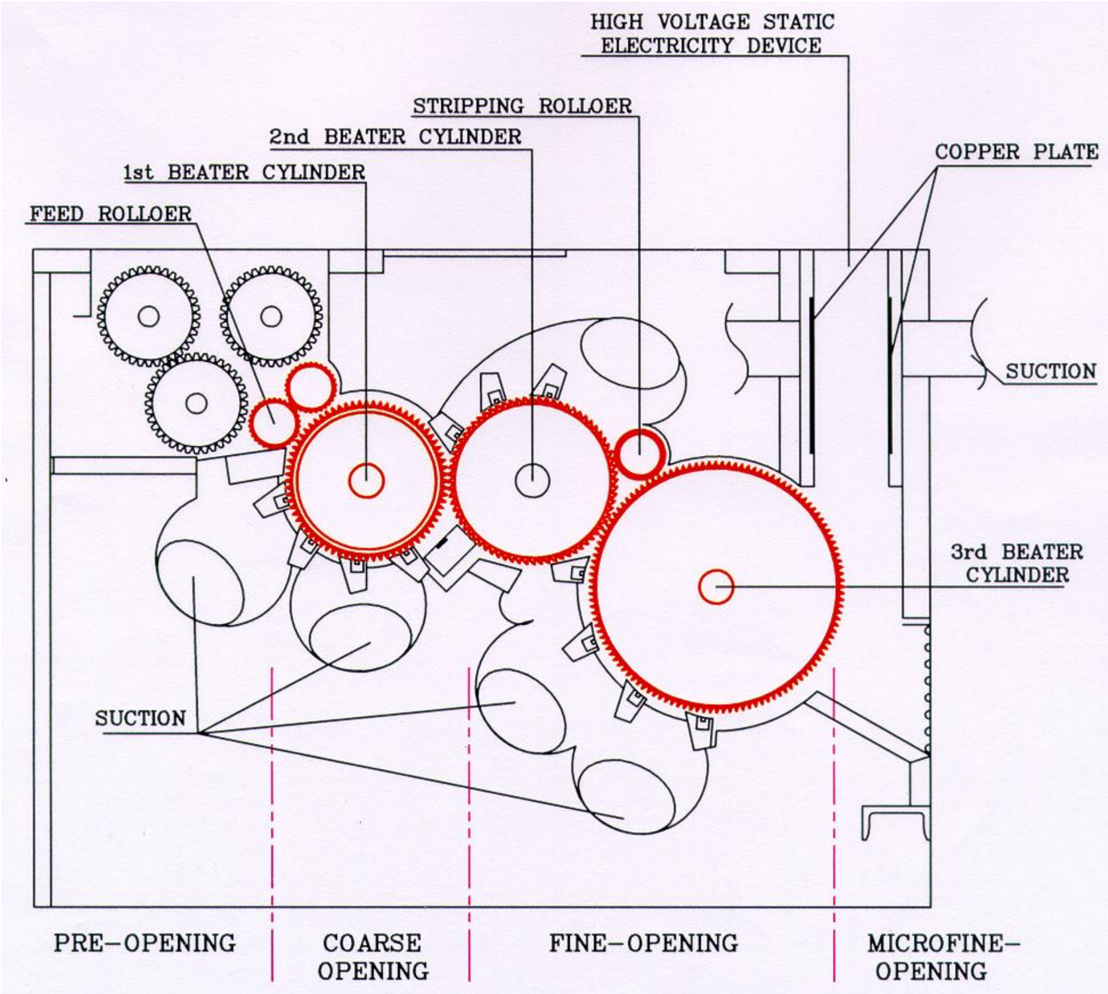
FCT : No. /g, SFC= Short fiber content

Table 6. The mill testing results after HVEO.

	Trash	Dust	Seed coat F	Neps
MDTA3	1.48%	0.07%	0.1%	-
AFIS	-	-	-	350
AFIS	Fiber length= 29.2mm		SFC = 6.2%	
FCT	69	-	81	200

FCT : No./g, Short fiber content

Figure 1. Diagram of a high voltage electrostatic opener.



A = Raw material; B = Card mat (Lap); C = Card Sliver; D = Sliver from Breaker drawing; E = Lap of doubling; F = Combed sliver; G = Sliver from Finisher drawing; H = Roving