

9.7 Cotton Ginning

9.7.1 General¹⁻⁸

Cotton ginning takes place throughout the area of the United States known as the Sunbelt. Four main production regions can be designated:

- Southeast—Virginia, North Carolina, South Carolina, Georgia, Alabama, and Florida
- Mid-South—Missouri, Tennessee, Mississippi, Arkansas, and Louisiana
- Southwest—Texas and Oklahoma
- West—New Mexico, Arizona, and California

The majority of the ginning facilities are located in Texas, Mississippi, Arkansas, California, and Louisiana.

The industry trend is toward fewer gins with higher processing capacity. In 1979, 2,332 active gins in the United States produced 14,161,000 bales of cotton. By the 1994/1995 season, the number of cotton gins in the United States dropped to 1,306, but about 19,122,000 bales were produced. The average volume processed per gin in 1994/1995 was 14,642 bales.

Cotton ginning is seasonal. It begins with the maturing of the cotton crop, which varies by region, and ends when the crop is finished. Each year the cotton ginning season starts in the lower Southwest region in midsummer, continues through the south central and other geographical regions in late summer and early autumn, and ends in the upper Southwest region in late autumn and early winter. Overall, U. S. cotton is ginned between October 1 and December 31, with the bulk of the crop from each geographical region being ginned in 6 to 8 weeks. During the remainder of the year, the gin is idle.

All U. S. cotton in commercial production is now harvested by machines of two types, picking and stripping. Machine-picked cotton accounts normally for 70 to 80 percent of the total cotton harvested, while the rest is machine stripped. Machine picking differs from machine stripping mainly in the method by which the cotton lint and seed are removed from the plant. Machine picking is done by a spindle picker machine that selectively separates the exposed seed cotton from the open capsules, or bolls. In contrast, the mechanical stripper removes the entire capsule, with lint plus bract, leaf, and stem components in the harvested material.

Strippers collect up to six times more leaves, burs, sticks, and trash than the spindle picker machines. This higher ratio of trash to lint requires additional equipment for cleaning and trash extraction. Stripper-harvested cotton may produce 1,000 pounds of trash per 500-pound bale of lint, compared to 150 pounds of trash per 500-pound bale from spindle picking.

The modular system of seed cotton storage and handling has been rapidly adopted. This system stores seed cotton in the field after harvesting until the gin is ready to process it. Modules can also be transported longer distances, allowing gins to increase productivity. In 1994, 78 percent of the U.S. crop was handled in modules.

9.7.2 Process Description^{2,5-7}

Figure 9.7-1 is a flow diagram of a typical cotton-ginning process. Each of the five ginning steps and associated equipment is described below.

9.7.2.1 Unloading System -

Module trucks and trailers transport cotton from the field to the gin. A pneumatic system removes the cotton from the trailers, and either a pneumatic system or a module feeder removes the cotton from modules. A combination conveyor and pneumatic system conveys the cotton to a separator and feed control unit. Prior to this first separator point, some gins use a stone and green boll trap for preliminary trash removal. The screen assembly in the separator allows air to escape but collects the cotton and allows it to fall into the feed control unit. The conveying air flows from the separator to a cyclone system, where it is cleaned and discharged to the atmosphere.

9.7.2.2 Seed Cotton Cleaning System -

Cotton is subjected to three basic conditioning processes--drying, cleaning, and extracting--before it is processed for separation of lint and seed. To ensure adequate conditioning, cotton gins typically use two conditioning systems (drying, cleaning, and extracting) in series.

Seed cotton dryers are designed to reduce lint cotton moisture content to 5 to 8 percent to facilitate cleaning and fiber/seed separation. A high-pressure fan conveys seed cotton through the drying system to the first seed cotton cleaner, which loosens the cotton and removes fine particles of foreign matter (e. g., leaf trash, sand, and dirt). In the second cleaner, large pieces (e. g., sticks, stems, and burs) are removed from the cotton by a different process, referred to as "extracting". Different types of extractors may be used, including bur machines, stick machines, stick and bur machines, stick and green leaf extractors, and extractor/feeders. These machines remove burs, sticks, stems, and large leaves, pneumatically conveying them to the trash storage area. The cotton is pneumatically conveyed to the next processing step. Typically, all conveying air is cleaned by a cyclone before being released to the atmosphere.

9.7.2.3 Overflow System -

After cleaning, the cotton enters a screw conveyor distributor, which apportions the cotton to the extractor/feeders at a controlled rate. The extractor/feeders drop the cotton into the gin stands at the recommended processing rates. If the flow of cotton exceeds the limit of the extractor/feeder systems, the excess cotton flows into the overflow hopper. A pneumatic system (overflow separator) then returns this cotton back to the screw conveyor distributor, as required. Typically, the air from this system is routed through a cyclone and cleaned before being exhausted to the atmosphere.

9.7.2.4 Ginning and Lint Handling System -

Cotton enters the gin stand through a "huller front", which performs some cleaning. Saws grasp the locks of cotton and draw them through a widely spaced set of "huller ribs" that strip off hulls and sticks. (New gin stands do not have huller ribs.) The cotton locks are then drawn into the roll box, where fibers are separated from the seeds. After all the fibers are removed, the seeds slide down the face of the ginning ribs and fall to the bottom of the gin stand for subsequent removal to storage. Cotton lint is removed from the saws by a rotating brush, or a blast of air, and is conveyed pneumatically to the lint cleaning system for final cleaning and combing. The lint cotton is removed from the conveying airstream by a condenser that forms the lint into a batt. The lint batt is fed into the first lint cleaner, where saws comb the lint cotton again and remove part of the remaining leaf particles, grass, and motes. Most condensers are covered with fine mesh wire or fine perforated metal, which acts to filter short lint fibers and some dust from the conveying air.

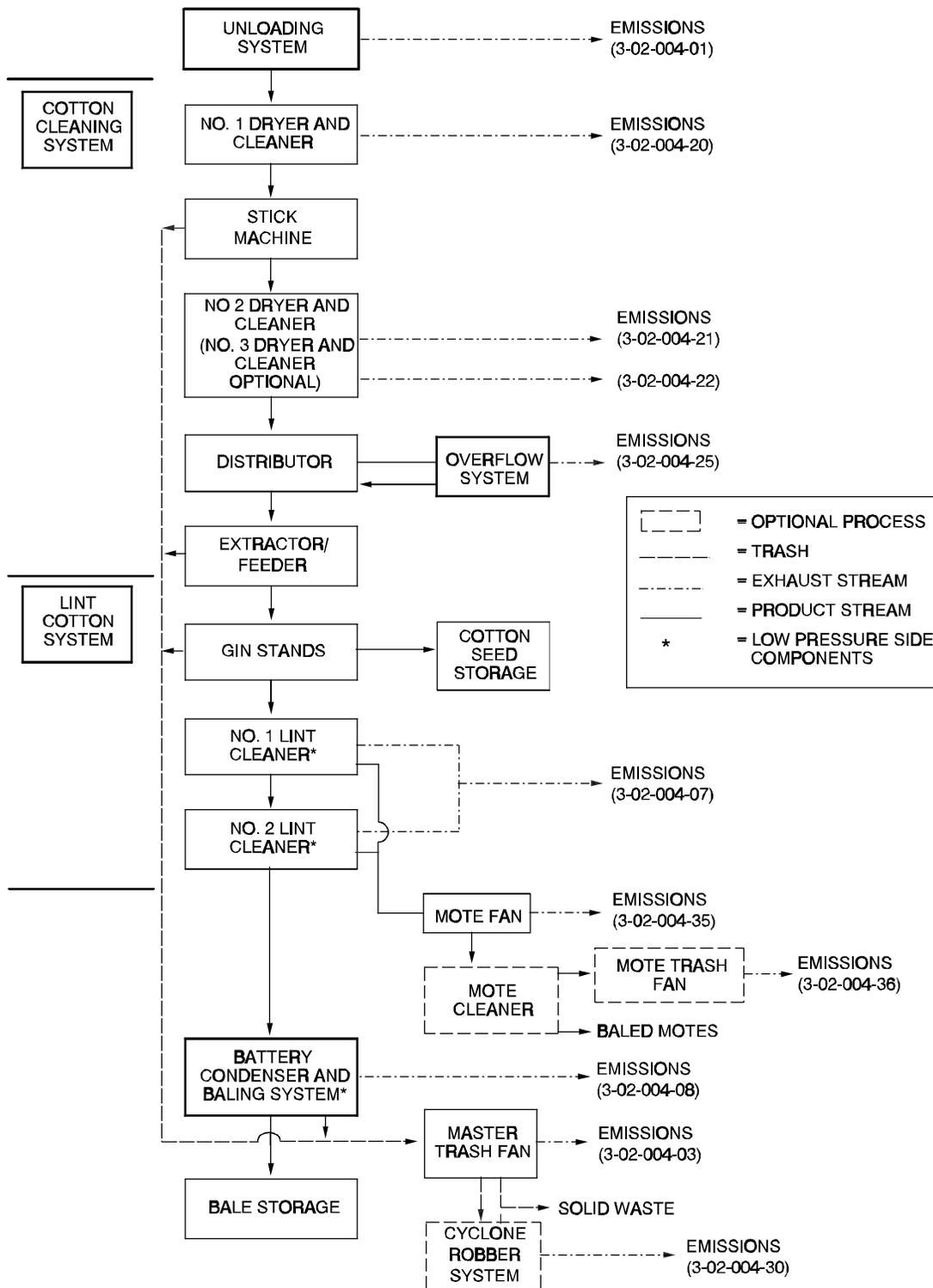


Figure 9.7-1. Flow diagram of cotton ginning process.
(Source Classification Codes in parentheses.)

9.7.2.5 Battery Condenser And Baling System -

Lint cotton is pneumatically transported from the lint cleaning system to a battery condenser, which is a drum covered with fine mesh screen or fine perforated metal that separates the lint cotton from the conveying air. The lint cotton is formed into batts and fed into a baling press, which compresses the cotton into uniform bales.

Most gins use a double-press box for packaging the cotton into bales. The lint drops into one press box and fills it while a bale is being pressed and strapped in the other box. Approximately 480 lb (217 kilograms [kg]) of cotton is pressed into a bale before it is wrapped with a cover and strapped. Modern gins are presently equipped with higher-tonnage bale presses that produce the more compact universal density cotton bales. In 1995, 96 percent of the U.S. crop was pressed into universal density bales at the gins. The finished cotton bale is transported to the textile mill for processing into yarn. Motes are sometimes cleaned and baled also.

9.7.3 Emissions And Controls¹⁻²⁴

Particulate matter (PM) is the primary air pollutant emitted from cotton ginning. Available data indicate that about 37 percent of the total PM emitted (following control systems) from cotton ginning is PM less than or equal to 10 microns in aerodynamic diameter (PM-10). The PM is composed of fly lint, dust, fine leaves, and other trash. Figure 9.7-1 shows the typical PM emission points in the ginning process. Particulate matter emissions are typically greater at gins processing stripper-harvested cotton than at gins processing picker-harvested cotton. Also, PM emissions from the first cotton harvest at a given facility are typically lower than emissions from subsequent harvests.

Control devices used to control PM emissions from cotton ginning operations include cyclones, fine screen coverings, and perforated metal drums. Cyclones may be used to control the sources with high pressure exhaust or all of the operations at a gin. Two types of cyclones that are used are 2D-2D and 1D-3D cyclones. Both the body and the cone of a 2D-2D cyclone are twice as long as the cyclone diameter. The body of a 1D-3D cyclone is the same length as the diameter, and the cone length is three times the diameter. In many cases, 1D-3D cyclones display slightly higher PM control efficiencies than 2D-2D cyclones.

Screen coverings and perforated drums may be used to control PM emissions from sources with low-pressure exhaust, including the battery condenser and lint cleaners.

Table 9.7-1 presents PM and PM-10 emission factors for cotton gins controlled primarily by 1D-3D or 2D-2D cyclones. Emission factors for lint cleaners and battery condensers with screened drums or cages are also presented. Emission factors for total gin emissions are shown for two different gin configurations. The emission factors for "Total No.1" represent total PM and PM-10 emissions from gins with all exhaust streams controlled by high-efficiency cyclones. The emission factors for "Total No. 2" represent total PM and PM-10 emissions from gins with screened drums or cages controlling the lint cleaner and battery condenser exhausts and high-efficiency cyclones controlling all other exhaust streams. The emission factors for the No. 3 dryer and cleaner, cyclone robber system, and mote trash fan are not included in either total because these processes are not used at most cotton gins. However, these factors should be added into the total for a particular gin if these processes are used at that gin.

Table 9.7-1. EMISSION FACTORS FOR COTTON GINS CONTROLLED WITH HIGH-EFFICIENCY CYCLONES^a

Source	Total PM, lb/bale	EMISSION FACTOR RATING	PM-10, lb/bale	EMISSION FACTOR RATING
Unloading fan (SCC 3-02-004-01)	0.29 ^b	D	0.12 ^c	D
No. 1 dryer and cleaner (SCC 3-02-004-20)	0.36 ^d	D	0.12 ^e	D
No. 2 dryer and cleaner (SCC 3-02-004-21)	0.24 ^f	D	0.093 ^g	D
No. 3 dryer and cleaner ^h (SCC 3-02-004-22)	0.095	D	0.033	D
Overflow fan ^j (SCC 3-02-004-25)	0.071	D	0.026	D
Lint cleaners (SCC 3-02-004-07) with high-efficiency cyclones ^k with screened drums or cages ^m	0.58	D	0.24	D
	1.1	E	ND	NA
Cyclone robber system ⁿ (SCC 3-02-004-30)	0.18	D	0.052	D
Mote fan (SCC 3-02-004-35)	0.28 ^p	D	0.13 ^q	D
Mote trash fan ^r (SCC 3-02-004-36)	0.077	D	0.021	D
Battery condenser (SCC 3-02-004-08) with high-efficiency cyclones ^s with screened drums or cages ^m	0.039	D	0.014	D
	0.17	E	ND	NA
Master trash fan (SCC 3-02-004-03)	0.54 ^t	D	0.074 ^u	D
Cotton gin total No. 1 ^v (SCC 3-02-004-10)	2.4	D	0.82	D
Cotton gin total No. 2 ^w (SCC 3-02-004-10)	3.1	E	1.2	E

^a Emission factor units are lb of pollutant per bale of cotton processed. Emissions are controlled by 1D-3D or 2D-2D high-efficiency cyclones unless noted. SCC = source classification code.

ND = no data available. To convert from lb/bale to kg/bale, multiply by 0.45.

^b References 13-15,17,19-20,22,24.

^c References 13-14,17,22,24.

^d References 12-14,17,19,21.

^e References 12-14,17,21.

^f References 9,12,14,17,19,24.

^g References 9,12,14,17,24.

^h References 10,16. Most gins do not include this source, and these emission factors are not included in the total gin emission factors shown. However, these factors should be added into the total for a particular gin if this source is part of that gin.

^j References 10,14,17,24.

^k References 13-14,17,21-23. Emission factors are included in Total No. 1, but are not included in Total No. 2.

^m References 18-20. Emission factors are not included in Total No. 1, but are included in Total No. 2.

ⁿ Reference 22. Most gins do not include this source, and these emission factors are not included in the total gin emission factors shown. However, these factors should be added into the total for a particular gin if this source is part of that gin.

^p References 11-14,17,19-20,23-24.

^q References 11-14,17,24.

^r References 10-11,22. Many gins do not include this source, and these emission factors are not included in the total gin emission factors shown. However, these factors should be added into the total for a particular gin if these sources are part of that gin.

^s References 14,16-17,23-24. Emission factors are included in Total No. 1, but are not included in Total No. 2.

^t References 15,19,22.

Table 9.7-1 (cont.).

^u References 15,22.

^v Total for gins with high-efficiency cyclones on all exhaust streams. Does not include emission factors for the No. 3 dryer and cleaner, cyclone robber system, mote trash fan, lint cleaners with screened drums or cages, and battery condenser with screened drums or cages.

^w Total for gins with screened drums or cages on the lint cleaners and battery condenser and high-efficiency cyclones on all other exhaust streams. Does not include emission factors for the No. 3 dryer and cleaner, cyclone robber system, mote trash fan, lint cleaners with high-efficiency cyclones, and battery condenser with high-efficiency cyclones. PM-10 emissions from lint cleaners and battery condensers with screened drums or cages are estimated as 50 percent of the total PM emissions from these sources.

9.7.4 Summary of Terminology

Bale — A compressed and bound package of cotton lint, typically weighing about 480 lb.

Batt — Matted lint cotton.

Boll — The capsule or pod of the cotton plant.

Bur (or burr) — The rough casing of the boll. Often referred to as hulls after separation from the cotton.

Condenser — A perforated or screened drum device designed to collect lint cotton from the conveying airstream, at times into a batt.

Cotton — General term used variously to refer to the cotton plant (genus *Gossypium*); agricultural crop; harvest product; white fibers (lint) ginned (separated) from the seed; baled produce; and yarn or fabric products. Cotton is classified as upland or extra long staple depending on fiber length.

Cottonseed — The seed of the cotton plant, separated from its fibers. The seeds constitute 40 percent to 55 percent of the seed cotton (depending on the amount of trash) and are processed into oil meal, linters, and hulls, or are fed directly to cattle.

Cyclone — A centrifugal air pollution control device for separating solid particles from an airstream.

Cyclone robber system - A secondary cyclone trash handling system. These systems are not used at most cotton gins.

Cylinder cleaner — A machine with rotating spiked drums that open the locks and clean the cotton by removing dirt and small trash.

Extractor — Equipment for removing large trash pieces (sticks, stems, burs, and leaves). The equipment may include one or more devices, including a stick machine, bur machine, green-leaf machine, and a combination machine.

Extractor-feeder — A device that gives seed cotton a final light extraction/cleaning and then feeds it at a controlled rate to the gin stand.

Fly lint (or lint fly) — Short (less than 50 μm) cotton fibers, usually emitted from condensers and mote fan.

Gin stand — The heart of the ginning plant where gin saws (usually several in parallel) separate the cotton lint from the seeds.

High pressure side — The portion of the process preceding the gin stand (including unloading, drying, extracting, cleaning, and overflow handling systems) in which material is conveyed by a higher pressure air, and exhausts are typically controlled by cyclones.

Lint cleaner — A machine for removing foreign material from lint cotton.

Lint cotton — Cotton fibers from which the trash and seeds have been removed by the gin.

Low pressure side — The portion of the process following the gin stand (including lint cotton cleaning and batt formation process) in which material is conveyed by low pressure air, and exhausts are typically controlled by condensers.

Mote — A small group of short fibers attached to a piece of the seed or to an immature seed. Motes may be cleaned and baled.

Picker harvester — A machine that removes cotton lint and seeds from open bolls with rotating spindles, leaving unopened bolls on the plant. "First pick" cotton is obtained from the initial harvest of the season. It usually contains less trash than "second pick" cotton, obtained later in the harvest season. "Ground cotton" is obtained by picking up between the rows at season's end and has a high trash content.

Seed cotton — Raw cotton, containing lint, seed, and some waste material, as it comes from the field.

Separator — A mechanical device (e.g., wire screen with rotary rake) that separates seed cotton from conveying air.

Stripper harvester — A machine that strips all bolls — opened (mature) and unopened (immature or green) — from the plant; strippers are used on short cotton plants, grown in arid areas of Texas, Oklahoma, and New Mexico. They collect larger amounts of trash (leaves, stems, and sticks) than picker harvesters.

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