Don Ethridge

PROCEEDINGS

GIN-WASTE-UTILIZATION and STICK-SEPARATION SEMINAR

MEMPHIS, TENNESSEE
MARCH 1977

AGRO-INDUSTRIAL REPORT

COTTON INCORPORATED

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PROCEEDINGS

of a

GIN WASTE UTILIZATION

and

STICK SEPARATION SEMINAR

March 4, 1977 Memphis, Tennessee

Sponsored by

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OPENING REMARKS

LON MANN

This meeting is an update on what is going on throughout the industry, from one side of the country to another, in every facet of what we can do with gin waste. The purpose of this meeting is to provide a forum from which this information can be published.

I would like first to ask Jack Hamilton, president of the Southern Ginners Association, if he would have a word to say.

JACK HAMILTON

We are glad to be cooperating in the meeting. I think everyone who has been dealing with the air control commissions in the various states knows that we are just not going to be able to continue burning as we are burning now, at least not in Louisiana, and I think the other four states in the Ginners Association are in the same boat. If the state people continue to cooperate, it is really not going to benefit us because I think the federal people are going to override them. So I think that, besides starting to solve some of the problems of increased waste and stripper harvesting, what we need now is to get some justification for temporary relief—to give us a little more time to try to solve this situation of gin trash and to devise a method that will get rid of it in a way which is satisfactory to them. So, we are real pleased to be cooperating with Cotton Incorporated and the National Cotton Council of America.

LON MANN

Thank you, Jack. Cotton Incorporated is responsible for putting this seminar together. "Farmer" Jones is in charge of it and has done a good job in getting probably the most knowledgeable people in the whole nation to deal with the subject here this morning. I would like to start out with our first speaker, Beverly Reeves, extension agricultural engineer for cotton mechanization and ginning, who is located here in Memphis.

REVIEW OF EXISTING HEAT-RECOVERING-INCINERATOR APPLICATIONS AT COTTON GINS

Beverly G. Reeves*

It is nice to be on the platform this morning. My thanks go to Cotton Incorporated for setting up this seminar. I agree, this is a worthy effort. It is certainly timely in light of current trends and developments. Most of you are familiar with the ginning process; however, there possibly are some in the audience who are not. So as a preface to my remarks on the state of the art of incineration and heat recovery, I would like to give a brief résumé of the ginning process.

Certainly today, with automation as it is in ginning machinery, the ginner "plays" his gin much like a pipe organ. Sitting at the controls he can do whatever is needed to process the crop of mechanically harvested cotton. He has dryers, cleaners and stick machines that he can route the cotton through and end up at the gin stands with a product that is in condition to separate from the seed with a minimum of trash. He then can process the lint through the lint cleaners utilizing bypass valves to fit the machinery used to the needs of the cotton. The control and flexibility of the plant allows the ginner to preserve the quality of the lint during the process and place it in the baling press. It comes out of the press packaged and ready to enter trade channels. The seed are placed in temporary storage to await delivery to oil mills or planting-seed processors. But today we are focusing on disposal of the trash that is removed from the cotton during the ginning process.

This trash can be categorized into two types: it is either organic material or inorganic material. The organic material is plant parts—burs, leaves, sticks, lint fly, and motes or immature seed. Thus, there is a pretty wide range of organic materials. The inorganic material, of course, is sand or dirt.

Fans are used in gins for conveying seed cotton, lint, seed and trash. This results in dusty, dirty, trash-laden air.

With the enactment of the Clean Air Act, gins were confronted with the problem of cleaning this air before it is returned to the environment. Cyclones and inline filters or fine-mesh condenser covers are used for that purpose. This equipment was developed by the Agricultural Research Service at the ginning research labs. It was commercialized by the gin machinery industry and thus has been of significant benefit to the ginning industry in coping with the trash collection problem.

As the trash is collected, it is placed in some kind of temporary storage facility. Some gins use twin, overhead dumping hoppers, one being used for woody plant parts, such as burs, sticks, stems and leaves, and the other for lint cleaner waste, a more fibrous material. At some installations line cleaner waste is baled in a hay baler or a flat-bale lint press. This material then moves into speciality fiber markets. The main problem today though, I believe, is what shall we do with the woody plant parts?

In the early days of mechanical harvesting in West Texas, the Texas Agricultural Extension Service had a good program. We were applying gin trash, burs and other woody parts to cropland at rates ranging from two to four tons per acre. Plowing this material under resulted in yield increases that paid good dividends. This caused ginners to stop using their jug and teepee burners. Burner maintenance was costly, primarily because of glass buildup in the bottom of the burner. This plugged the vents and upset the burning process. Smoke and odors were then emitted until the glass was removed. It was a molten mass and had to be broken with an air hammer. Heat recovery was not being considered at that time, so burning was thought of as a wasteful disposal method, and it was a dead

*Extension Agricultural Engineer, Cotton Mechanization & Ginning, USDA Extension Service, Memphis, Tennessee.

expense since no revenue was collected by the gin. The cost of a bur hopper and a distributor truck was about the same as that of a burner, so hauling was acceptable to West Texas ginners. Farmers were standing in line for burs for several years, but eventually they became disenchanted. Propagation of weeds and spread of plant diseases led them to decide that spreading gin waste on fields was not an acceptable practice. So, during the last eight to ten years ginners have been searching for ways to utilize these woody plant parts to better advantage.

Inorganic material that comes from blowing or splashing soil will be found with the woody plant material. When gins are collecting or paying a trash hauling fee, it is a common practice to perforate the trough of the screw conveyer trunkline under a bank of cyclones so dirt can be screened out of the trash. This brings into focus an important factor that we need to reconcile as we begin trying to utilize these woody plant parts as a heat source. We must separate the dirt from the trash to minimize glass formation in the incinerator fire box. Gin trash burns well, about like paper, and yet not exactly like paper. The inexperienced say they will have no problem burning gin trash, but there are unusual problems. These are due partly to this complicating factor of inorganic material entrained in the organic parts. Variable moisture content, composition and flow rates are other complicating factors.

In the earlier days of mechanical harvesting, teepee and jug-type burners were used to a good advantage in disposing of this material. This was especially true in the spindle picker areas where wet fields many times prohibited bur applications on cropland. But then, the Clean Air Act was enacted. Open-pit burning was outlawed, and the definition of an approved incinerator was worked out. This put teepee and jug-type burners out of operation. An incinerator, by the Clean Air Act definition, is a multichamber unit that will give complete combustion and opacity and particular emissions that will meet criteria established by local standards.

In the late 60's the Agricultural Research Service at the Stoneville Ginning Lab began focusing on the possibility of utilizing heat recovery from trash incineration and installed a Consumat incinerator in 1972. Tests have been under way since that time, and the results are impressive. They determined that the heat content of gin trash averages about 7000 Btu per pound. They also determined that the ash content averages about eight percent in soil-free trash. Then an air-to-air heat exchange system was developed that is adaptable to the seed cotton drying system of a gin. This unit can recover better than 30 percent of the heat of trash incineration and deliver it to the drying system in the proper volume of air at temperatures in the proper range for seed cotton drying.

Some of the commercial developments that surfaced shortly after the Clean Air Act came into being have evolved into today's operational units. Ecology Enterprises (Taylor Headley) has been one of the innovators in the field. During the 1976 ginning season their unit at Drake Ginnery, Drake, South Carolina, passed the South Carolina emission standard. In Arkansas, Mr. Mullins, Mr. Hunter and Mr. Murchison have been working in a joint venture to develop a unit now known as the Gin-Ener-Ator. The test unit at Frank Murchison Gin, Coy, Arkansas, has been stack sampled and has passed the Arkansas emission standard.

Several heat recovery incinerator projects have been launched in Arkansas—the projects at Monette, Schugtown and Coy. All these exist under a program sponsored by the Arkansas Air Pollution Control Commission. They viewed gin trash disposal as a critical problem. Incineration of the material offered an alternate heat source for seed cotton drying, yet there was a lack in technology. So they encouraged incinerator designers to set up demonstrations at gins in their states by allowing construction and start-up variances. Research funds were also granted to get some of these projects started. This cooperative effort gave a big boost to the state of development of gin trash incineration and heat recovery.

The California Ginners Association worked in the California legislature and obtained passage of a bill that allows open burning of gin trash under permit on a fee basis for the next couple of seasons. Monies derived from that fee will go into a research and development fund. This fund will be used to finance projects designed to solve the gin trash disposal problem. The primary focus will be on development of gin trash incineration technology and compliance with incinerator emission standards so heat can be recovered for utilization in the ginning process. This program will also give long range benefits to ginners, not only in California but across the Cotton Belt.

In Schugtown, Arkansas, a Meyer incinerator was installed at Schugtown Co-op Gin in 1975. They had earlier installations at Gould, Arkansas, and at Wynnburg Cotton Co., Wynnburg, Tennessee. Ecology Enterprises had a unit at A. J. Buffler Gin, Oakland, Alabama (1974) and later (1975) at Kiech-Shauver Gin Co., Monette, Arkansas. A unit in South Carolina was their initial installation in about 1972. This was updated in 1976 to modern standards including heat recovery. A Gin-Ener-Ator is now under construction at Mounds-Neighbors Gin, Rector, Arkansas. Agrotherm, Los Angeles, California, installed a unit at J. G. Boswell Gin Co., Corcoran, California, in 1976 and subjected it to shakedown tests. Valley Fabrication Engineers, Fowler, California, have installed and tested a unit at West Valley Cotton Growers Gin, Riverdale, California. Thus we are getting several demonstration units in the field.

We have a lot of people working on gin trash incineration and heat recovery, and I think we are making good progress. No doubt, as a result of this seminar, when the gins start running again this fall, we will have more new technology in place. We will be moving toward the solution of the really urgent problem of gin trash disposal and will recover some usable energy in the process.

PROGRESS OF INCINERATION RESEARCH AT STONEVILLE[1, 2, 3]

O. L. McCaskill, R. A. Wesley and W. S. Anthony*

Of the many cotton gin waste disposal methods being tried today, incineration is the simplest for the ginner. Several incinerator manufacturers are working on the development of a heat-recovering incineration system for the disposal of cotton gin waste that they hope will meet state air pollution standards.

The potential for heat recovery from incineration of cotton gin trash for a single ginning operation can be clearly seen in Table 1. Adequate heat is available and can be recovered even in low-capacity gins. Only the size and volume of the ginning operation will dictate whether such recovery will be economically feasible.

The U. S. Cotton Ginning Research Laboratory (USCGRL) at Stoneville, Mississippi, has installed and modified a small, multichamber incinerator to study its ability to dispose of cotton gin waste. The incinerator is a Consumat Model C-125 rated at 470 lb/hr of municipal waste. It operates on the controlled-air principle. Waste is heated in the lower chamber by control of air introduction which, in turn, controls the temperature. This system results in very low air velocities in the lower chamber so that ash particles are not entrained and carried to the upper chamber. Only smoke, unburned gases, and very small particles pass into the upper chamber. In the upper chamber the smoke is reheated and additional air is introduced so that the gases and smoke particles are oxidized rapidly. The high-temperature gases leave the upper chamber and enter the heat exchanger where they are cooled by ambient air that passes through the heat exchanger.

A schematic of the modified heat-recovery inciner-

Table 1. Potential for heat recovery from incineration of gin trash[1]

Processing rate bales/hr	Heat from combustion[2]	30% heat recovery for drying	Average heat required for drying[3]
		Million Btu per hour	
6	8.4	2.5	2.3
8	11.2	3.4	3.0
10	14.0	4.2	3.8
12	16.8	5.0	4.6
15	21.0	6.3	5.7
20	28.0	8.4	7.6
25	35.0	10.5	9.5
30	42.0	12.6	11.4

[1]McCaskill, O. L. and R. A. Wesley. "Energy from Cotton Gin Waste," Texas Cotton Ginners' Journal & Yearbook, March 1976, pp. 5, 8, 10, and 12-14.

[2]Based on 200 pounds of trash per bale, with a heat value of 7,000 Btu per pound.

[3]Based on an average of 380,000 Btu per bale (Holder, Shelby H., and McCaskill, Oliver L. "Cost of Electric Power and Fuel for Driers in Cotton Gins, Arkansas and Missouri." ERS-138, Oct. 1963.)

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[1]For presentation at a Cotton Incorporated seminar on Gin-Waste-Utilization and Stick-Separation, March 4, 1977, Memphis, Tennessee, and publication in their proceedings.

[2]In cooperation with State Agricultural Experiment Stations.

[3]Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the U. S. Department of Agriculture and does not imply approval to the exclusion of other products that may be available.

*Agricultural Engineers, U. S. Cotton Ginning Research Laboratory, Agricultural Research Service, U. S. Department of Agriculture, Stoneville, Mississippi.

ation system is shown in Figure 1. The system is composed of a continuous trash feeder, two burning chambers, a heat exchanger in the stack, a modulating hot air mixing valve, and a conventional gin-drying system. The simple, continuous-trash-feed system consists of a high-efficiency cyclone that is equipped with a vacuum feeder that discharges into a screw conveyor. The screw conveyor is overhung for elimination of the end bearing at the incinerator (Fig. 2).

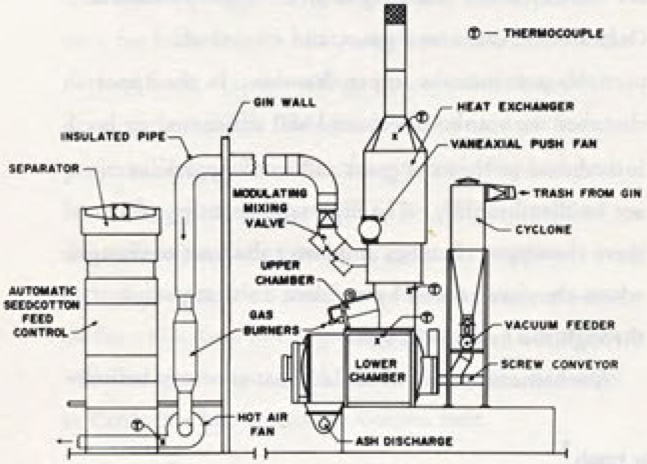

FIGURE 1. Schematic of heat-recovery incineration system.

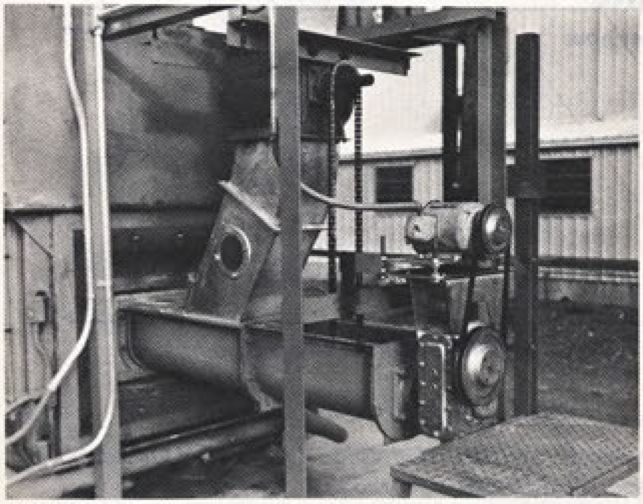

FIGURE 2. Continuous trash feed into incinerator.

A plug of gin waste is formed at the end of the screw conveyor before it enters the incinerator chamber, thereby protecting the screw from the high temperatures inside.

HEAT EXCHANGER

We installed a vane-axial fan at the inlet to the heat exchanger to insure positive pressure of the ambient air in the heat exchanger, to overcome the static-pressure loss caused by the heat exchanger, and to insure continuous flow of ambient air through the heat exchanger to prevent damage by excess heating. The ambient air moved in a cyclone path through the heat exchanger. The heat exchanger is cylindrical in shape and is composed of three coaxial cylindrical chambers (Fig. 3). Ambient air enters the outer preheating chamber tangentially at the bottom and moves upward in a cyclone path to the top of the chamber. This upward movement is parallel to the stack gases. The ambient air then moves through two ducts that cross through the stack gas chamber into the inner chamber. From here it moves downward in a cyclone path to the bottom of the inner chamber where it exits the heat exchanger. This downward travel is counterflow to the stack gases and produces the maximum temperature gradient for heat transfer. The inner cylinder is equipped with four sets of 3-inch fins on an 18-inch pitch that extends the full length

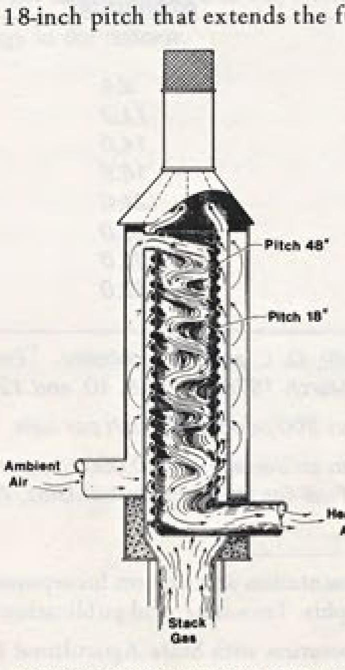

FIGURE 3. Cutaway of heat exchanger designed by U. S. Cotton Ginning Research Laboratory

of the cylinder. The outer preheating chamber was not equipped with fins.

The stack gases enter the heat exchanger at the bottom and travel through the middle cylindrical chamber to the stack. This path allows heat to be transferred into the outer preheating chamber, as well as into the inner chamber. The stack gas chamber is equipped with four sets of 6-inch fins on a 48-inch pitch that are welded to the inner cylinder. These fins increase the surface area exposed to the high temperature and the stack gas dwell time.

The outer cylinder was fabricated from 16-gage black steel, whereas all the inner cylinder walls and fins were fabricated from 16-gage, Type No. 316 stainless steel. It may be necessary to substitute a better material which is capable of withstanding prolonged elevated temperatures such as those experienced during these tests. We equipped the cylinder wall between the preheating chamber and the stack gas chamber with a slip joint to allow for expansion and contraction due to change in temperature.

CONTROL SYSTEM

The control system is composed of a modulating mixing valve, a conventional gin-type gas burner, and a conventional gin-type temperature controller. The heated air delivered from the heat exchanger enters a specially designed, modulating hot air mixing valve (Fig. 4). This valve is controlled by the gin's drying system controller and is capable of (1) discharging heated air to the atmosphere, (2) directing it to the gin's drying system, or (3) mixing it in the desired proportion with ambient air going to the drying system.

The conventional gas burner was connected in series with the heat exchanger (Fig. 1). The gas burner then could assist with initial startup and could supplement the heat exchanger if it became necessary. Both the modulating valve and the gas burner were regulated by the same temperature controller. The incinerator heat exchanger was the primary heat source, and the gas burner was the secondary source.

Figure 5 shows the wiring diagram for the temperature control system, in which a Honeywell temperature controller and valve motors are used. The modulating motor for the hot air mixing valve is a Honeywell Series 831E1, equipped with clockwise and counterclockwise limit switches. It is also equipped

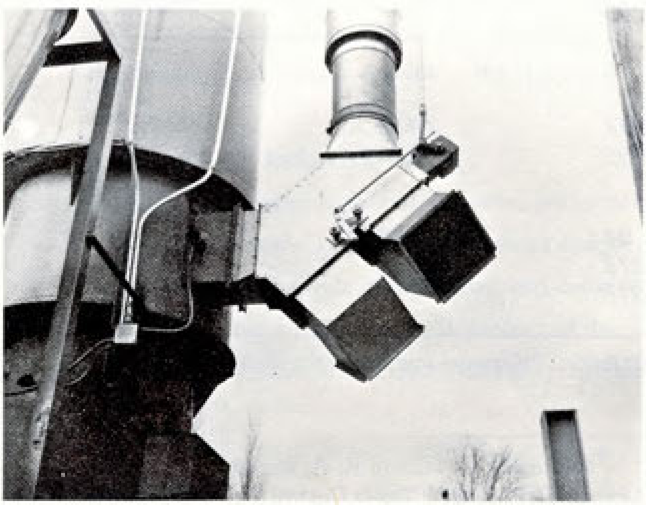

FIGURE 4. Modulating hot air mixing valve.

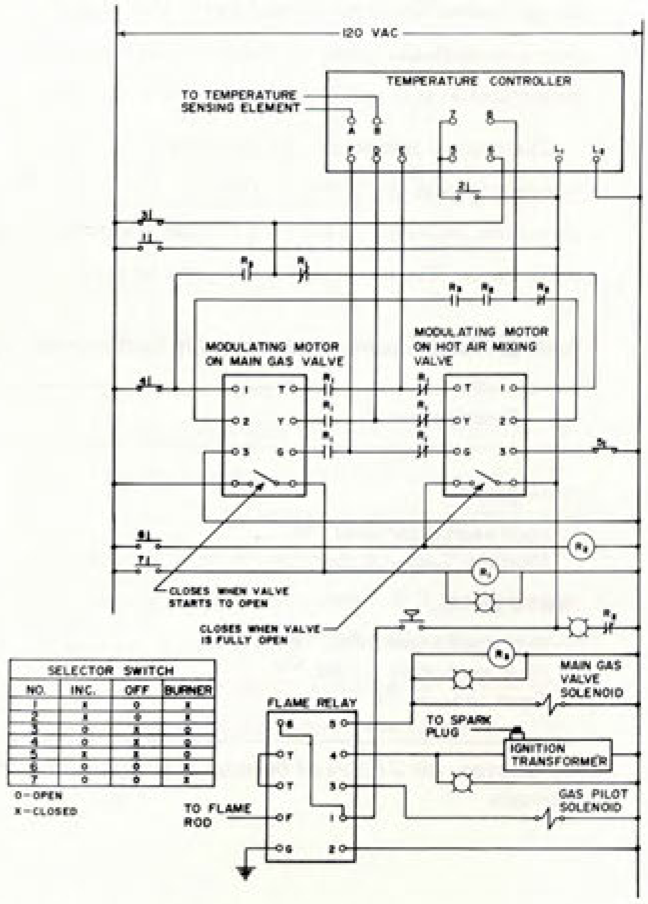

FIGURE 5. Control wiring diagram for heat-recovery system.

with an auxiliary, adjustable, cam-operated switch, as shown in the diagram. The existing modulating motor on the natural gas valve was modified and equipped with an auxiliary switch. Two additional relays and a three-position, multigang switch completed the control system. The three-position selector switch allows a ginner to use the gas burner only when the incinerator is not in use, or he can select heat from the incinerator, with the gas burner furnishing supplemental heat only. When the selector switch is turned to the "Off" position, the hot air mixing valve at the heat exchanger automatically closes and discharges the heat from the incinerator to the atmosphere. When the selector switch is in the incinerator position and the controller calls for heat, the hot air mixing valve opens until the desired temperature is reached in the gin's conventional drying system. If the desired temperature is not reached when the valve is fully open, the control system automatically switches on the gas burner for supplemental heat. The system then automatically turns off the gas burner when the incinerator heat is sufficient to satisfy the demand.

The average temperatures encountered in the heat-recovery system are shown in Table 2. The average air volume delivered to the feed control was 6,630 std ft^3/min. The heat recovered by the heat exchanger and delivered to the feed control was almost one million Btu/hr from the burning of only 450 lb of waste/hr, with an overall system recovery efficiency of almost 31 percent as follows:[4]

From combustion (450 lb/hr)	3,150,000 Btu/hr
At feed control (302°F)	1,759,000 Btu/hr
Ambient air (91°F)	794,000 Btu/hr
Recovered heat	965,000 Btu/hr
System efficiency	30.63 percent

STACK EMISSION TESTS

Stack emission tests were performed by Environmental Protection Systems, Jackson, Mississippi, on June 4, 1976 (Fig. 6).

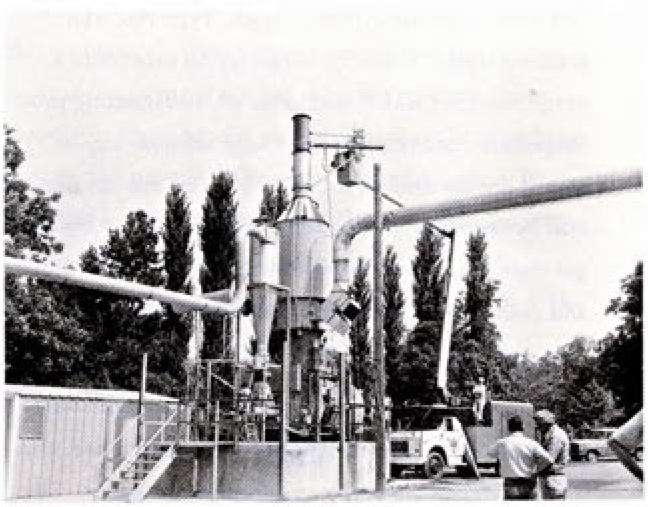

FIGURE 6. Heat-recovery incineration system during stack emission tests.

Table 2. Temperatures encountered in heat-recovery system[1]

Description	High	Low	Average
Stack gas at			
Heat exchanger inlet, °F	*2,357*	*2,116*	*2,251*
Heat exchanger outlet, °F	*795*	*620*	*701*
Heated air at			
Heat exchanger inlet, °F	*94*	*88*	*91*
Heat exchanger outlet, °F	*376*	*277*	*337*
Feed control, °F	*318*	*261*	*302*

[1]Average for 3 hours of burning at a trash feed rate of 450 lb/hr. Temperatures were recorded at 1-minute intervals.

[4]McCaskill, O. L., and R. A. Wesley. "Energy from Cotton Gin Waste." Texas Cotton Ginners' Journal & Yearbook, March 1976.

The methods and procedures used for this performance evaluation were those outlined in the Federal Register, Volume 36, Number 247, Part II, as promulgated by the Environmental Protection Agency (EPA). The incinerator was operated continuously throughout the sampling period for three replicated tests at an average feed rate of 383 lb/hr of cotton-ginning wastes. The operating feed rates for tests one, two, and three were 350, 400, and 400 lb/hr, respectively. The particulate emissions as determined by these tests are shown in Table 3. These tests showed the average calculated emission to be 0.36 grain/dry std ft^3, corrected to 12 percent CO_2. The allowable emission is as low as 0.20 grain/dry std ft^3 in some cotton-producing states.

is equivalent to 2,200 Btu/lb of gin trash burned.

The control system responded to the needs of the gin drying system by supplying heat from the incinerator as the primary source and by activating the gas burner for supplemental heat when necessary. Once the incinerator reached operating temperature no additional heat from the gas burner was necessary.

This particular incineration system has not undergone the prolonged operation that would be encountered at a commercial cotton gin. Therefore, no conclusions can be reached pertaining to such factors as the expected life of the system, whether glass formation would be a problem, or whether the automatic ash-discharge system would operate satisfactorily.

The particulate emission, which was found to be slightly above the allowable 0.20 grain per dry standard cubic foot could be due to very fine silica aerosols normally associated with high temperature incineration of agricultural wastes or to the excess air used during the tests. The excess air averaged 380 percent and was used in an attempt toward burning at the rated capacity of the incinerator. It is possible that a reduction of excess air to 150 to 200 percent would have reduced the emission considerably but, at the same time, would have reduced the capacity of the incinerator.

Table 3. Summary of particulate emission

Test No.	Trash feed rate lb/hr	Emission[1] Concentration, grains/ds ft^3 [2]	Emission[1] Rate, lb/hr
1	*350*	*0.2936*	*2.0*
2	*400*	*.3430*	*2.4*
3	*400*	*.4445*	*3.2*
Avg.	*383*	*.3604*	*2.5*

[1]Corrected to 12 percent CO_2. Percentage of isokinetic sampling = 99%.
[2]ds ft^3 = dry standard cubic foot.

The median particle size was 2.4 micrometers in diameter, and 75 percent of the particles were less than 5 micrometers in diameter. Chemical analysis indicated no pesticides or arsenic in the stack emission.

SUMMARY OF RESULTS

The heat-recovery incineration system performed well during all tests. The heat exchanger as designed by USCGRL was capable of recovering and delivering to the gin drying system almost 31 percent of the available heat from combustion. This recovered heat

EXPERIMENTAL DATA ON THE PERFORMANCE OF TWO HEAT-RECOVERING INCINERATORS AT COTTON GINS

William F. Lalor*

INTRODUCTION

This discussion does not concern hardware because several papers in these proceedings discuss hardware. This paper concerns the performance of the two machines we studied over the past two years. It is divided into two areas.

The first is a discussion of the data we collected during the operational study of two incinerators, one located in Monette, Arkansas, and the other in the San Joaquin Valley in California. The amount of heat recovered, the amount of gas used and other aspects are discussed. At the end, there should be no doubt that there is enough heat and that equipment is available to recover that heat and deliver it to gins tor drying seed cotton without supplemental heat.

The second area tells about some properties of gin waste—how much exists, what is in it in terms of moisture, heat, chemical residues (that is, residues of chemicals applied to the crop) and soil-derived material. This is based on the work of Curley and Miller of University of California Extension Service.[a]

INCINERATORS

Heat Recovery

The drying heat needed per bale is shown in Table 1, and approximate costs are shown in Table 2.

Table 1. Drying heat requirements per bale

	350–450 Cu. Ft. Natural Gas
OR	*3.5–4.5 Gal. LP Gas*
OR	*Heat from 150 lb Gin Waste*

Table 2. Drying cost per bale

With Natural Gas	*$0.40 to $1.00*
With LP Gas	*$1.00 to $2.00*
With Gin-Waste Heat	*$0.50 to $2.50*

For the incinerator, ginning rate determines what the equipment costs in the first place, but annual volume determines the drying cost per bale.

In the 1975 ginning season, the incinerator we studied was installed in Monette, Arkansas, by Ecology Enterprises of Dadeville, Alabama. It was instrumented extensively with temperature and airflow-measurement equipment whose output was fed to two recorders to give simultaneous records for calculating the heat recovery. A full report of the 1975 study is available as an Agro-Industrial Report from Cotton Incorporated.

In 1976, hand-held flow-measuring equipment was used instead of the permanently installed equipment. Tests at Monette were done on four different days. In California we ran five 3-hour tests on five different days. Air and heat flow measurements were made upstream of the temperature controls in Monette. (See Figure 1.)

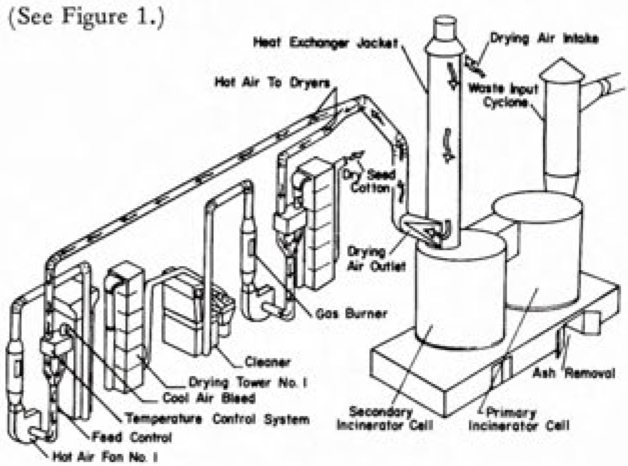

FIGURE 1. Schematic view of the incinerator in the Arkansas study.

Figure 2 is a schematic diagram of the California installation. Air and heat flow measurements were made in each duct leading to the dryers, and in the clean air inlet.

*Manager, Systems Engineering Research, Cotton Incorporated, Raleigh, North Carolina.

[a]Robert G. Curley and George E. Miller, Extension Agricultural Engineers, University of California, Davis, private communications about results of studies partially supported with Cotton Incorporated funds.

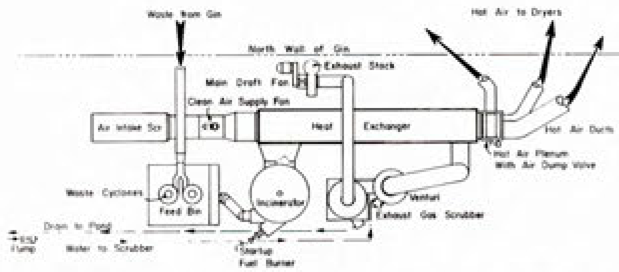

FIGURE 2. Schematic view of the incinerator in the California study.

The amount and source of heat used in the gin in Monette is shown in Table 3, in terms of gallon-equivalents of LP gas. Normal LP gas requirement for drying cotton is 3.5 to 4.5 gallons per bale.

Table 3. Amount and source of heat used in Monette test (gallon-equivalents of LP gas/bale)

Date	Ginning Rate (Bales/hour)	Seed Cotton Moisture	Gas	Incinerator	Total
10/14	*20*	*15.5%*	*0.3*	*0.9*	*1.2*
10/15	*19*	---	*1.4*	*0.0*	*1.4*
10/19 (Rain)	*16*	*13.7%*	*1.2*	*1.1*	*2.3*
*11/5**	*16*	*12.2%*	*0.0*	*1.4*	*1.4*

**Gas supply to gin interrupted.*

On the first day in Monette, with 15.5-percent-moisture seed cotton, the gas supplied 0.3 of a gallon-equivalent of propane heat per bale and the incinerator supplied 0.9 of a gallon-equivalent. This corresponds to supplying 25 percent of the heat from gas and 75 percent from the incinerator. On the second day the incinerator was down and the equivalent of 1.4 gallons per bale was being used in the form of gas. On the third day it was rainy and cool and the heat consumption was noticeably higher than 1.4 gallons per bale. The gas was supplying 1.2 gallons per bale and the incinerator was supplying the equivalent of another 1.1, for a total of 2.3 gallons per bale.

On November 5, the gas company terminated the supply of natural gas. The incinerator then supplied all the drying heat which, when we were measuring it, amounted to 1.4 gallon-equivalents of propane per bale. These gas consumption figures are much less than we had expected, but they are consistent with what we measured last year.

Table 4 shows the heat consumption at the California gin. The seed cotton moisture content in California was much less than in Arkansas, but consumption of propane was about four gallons per bale. This is due to a different ginning policy on the part of the people managing the gin.

On the first test day, November 9, of the 5.7 gallon-equivalents per bale being used by the gin, 4.9 were being supplied by the incinerator and 0.8 of a gallon was being supplied in the form of propane. On the second day, the incinerator was not operating and 4.3 gallons per bale was the total consumption of the gin; it was supplied in the form of propane. On the third day, it was foggy and cool, and the seed cotton moisture content was high. Considerably more heat was needed for drying; 5.4 gallon-equivalents per bale were being supplied by the incinerator, plus

Table 4. Amount and source of heat used in California test (gallon-equivalents of LP gas/bale)

Date	Ginning Rate (bales/hour)	Seed Cotton Moisture	Gas	Incinerator	Total
11/9	*23*	*8.6%*	*0.8*	*4.9*	*5.7*
11/11	*24*	*7.0%*	*4.3*	*0.0*	*4.3*
11/17 (Fog)	*22*	*9.0%*	*2.0*	*5.4*	*7.4*
12/6	*32*	*8.1%*	*4.5*	*0.0*	*4.5*
12/9	*29*	*7.4%*	*5.3*	*0.9*	*5.3*

the actual gas consumption, which was 2 gallons per bale.

On the remaining two test days, all the heat for the gin was supplied as propane. On one day it was 4.5 gallons per bale and on the next day it was 5.3 gallons per bale. The difference seemed due to the fact that the temperature controls were set for about 180°F on December 6 and 250°F on December 9. Whether or not this setting difference was justified is unknown.

The full amount of heat available in California was not always used. McCaskill and Wesley[b] postulated that with 30 percent heat exchanger efficiency, adequate heat to dry cotton would be available. We have a measure of the amount of heat recovered by the system in California (Table 5). On both days, when the incinerator was operating, it recovered 7.1 gallon-equivalents per bale. The dryers never needed that much heat and some of it was being vented. Excess heat was always available.

Gas Consumption

At the California gin, other components in the gin used heat besides the dryers. This was not true in Arkansas. In Arkansas there was no humidifier and the incinerator in Arkansas did not need any gas to support combustion from time to time. However, at the California gin some gas consumption was required for supporting complete combustion in the incinerator, similar to the gas needed to operate the incinerator in Stoneville (see page 12). In addition, the humidifier in California also consumed gas.

Table 6 shows how the gas was used in the gin. On November 9, the dryers were consuming no gas because all the heat for the dryers were being supplied by the incinerator. Gas required to support combustion in the incinerator was 0.2 of a gallon per bale. The humidifier consumption averaged about 0.6 of a gallon per bale. On November 17, the incinerator was operating, and no gas was consumed by the dryers. However, the incinerator was being run at a slightly lower temperature than on November 9, and somewhat higher gas consumption was needed to maintain combustion. If the incinerator cooled off a little as the gin slowed down momentarily, gas heat

Table 5. Recovered heat available and used (gallon-equivalents of LP gas per bale)

Date	Ginning Rate (bales/hour)	Heat Recovered	Heat Used	Percent Used
11/9	*23*	*7.1*	*4.9*	*69*
11/17	*22*	*7.1*	*5.4*	*76*

Table 6. Gas consumption by gin component (gallons of LP gas/bale)

Date	Ginning Rate	Dryers	Incinerator Combustion	Humidifiers	Total	
					With Incin.	W/O Incin.
*11/9**	*23*	*0.0*	*0.2*	*0.6*	*0.8*	---
11/11	*24*	*3.7*	*0.0*	*0.6*	---	*4.3*
*11/17**	*22*	*0.0*	*1.2*	*0.7*	*1.9*	---
12/6	*32*	*3.9*	*0.0*	*0.6*	---	*4.5*
12/9	*29*	*4.7*	*0.0*	*0.6*	---	*5.3*

**Incinerator operating.*

[b]McCaskill, O. L. and R. A. Wesley. 1976. Energy from cotton gin waste. The Cotton Ginners Journal and Yearbook, 44(1):5-14.

was used to keep the temperature up to the preset level.

The last column of Table 6 shows that from 3.5 to 4.5 gallons of propane per bale were saved when the incinerator was operating.

Air Quality Aspects

The stack emissions aspects of this equipment are important. We ran tests at the incinerator in Monette in 1975 and found that the emission levels were about twelve times that permitted by California and about six times that permitted by Arkansas, Mississippi and several other states. We did not run any tests at the California incinerator because a type of stack-gas scrubbing device was being used which had not been used before in this type of application. We believed that there were still some adjustments to be made before representative data could be obtained. There seems little doubt that particulate matter can be removed down to a level that will be acceptable to the air pollution control authorities.

One incinerator at Coy, Arkansas, was tested three times, twice by the state of Arkansas and once by a commercial lab. On each occasion the stack particulate emissions were less than 0.1 grain per standard cubic foot without any cleanup equipment on the stack. Drying heat is to be obtained direct from the flue gas in this incinerator rather than through a heat exchanger.

PROPERTIES OF GIN WASTE

Waste Per Bale

Some of the moisture-content data for seed cotton are shown in Tables 1 and 2. The turnout analysis for three different sets of cotton at Monette is shown in Table 7. The averages are omitted here because of the high variability, and they are of importance only in designing a surge hopper to feed an incinerator that burns at a constant rate.

All existing incinerators at gins except the one in California are designed to run directly on-line and to take the waste from the gin as it comes. Therefore, the range of feed rates over which the incinerator has to operate is what is really important. It is important because at the low end of the range the incinerator has to be designed to stay hot enough to accomplish complete combustion, and the heat exchanger has to be designed to extract the required heat. At the high end of the range, the incinerator has to be big enough not to overheat. Of course, there is no heat extraction problem at the high end of the range.

At both gins we had to determine the weight of gin waste per bale by arithmetic methods. Weight of waste per bale was the weight of seed cotton input less the weights of lint, seed and motes output. The weight of waste, calculated in this way, includes all weight losses throughout the process. Included are dust, lint fly, and moisture evaporated in the dryers from seed, lint and motes. We can safely assume that the weight loss in dust and lint fly is very small, but the loss caused by drying can easily be 50 pounds per bale. This loss is mistaken for waste weight unless all material weights entering and leaving the gin are the bone-dry weights. Using the moisture content of the

Table 7. Turnout analysis at Monette (pounds per 480-lb bale)

Date		Seed Cotton		Lint		Seed		Waste	
		Wt	MC	Wt	MC	Wt	MC	Wt	MC
10/14	*Wet*	*1566*	*15.5*	*480*	*5.3*	*820*	*14.2*	*266*	*21.9*
	Dry	*1323*		*454*		*703*		*166*	
10/19	*Wet*	*1455*	*13.7*	*480*	*6.5*	*820*	*14.5*	*154*	*18.5*
	Dry	*1256*		*449*		*701*		*106*	
11/5	*Wet*	*1439*	*12.2*	*480*	*6.4*	*792*	*12.3*	*167*	*18.6*
	Dry	*1263*		*450*		*695*		*118*	

waste to correct for this error is wrong. The wet-basis estimates of waste per bale are shown in Table 7 to illustrate the magnitude of the errors. Table 8 shows the turnout analysis for California. The error caused by using wet-weight estimates of waste is less in California than in Arkansas because of the lower moisture content of the California crop.

The weight of waste per bale varied from 118 pounds to 166 dry pounds in Arkansas in 1976. During our 1975 study we observed a range from 85 pounds to 184 pounds per bale. The California data contain a range from 103 to 236 dry pounds per bale. Some of the variability can be accounted for by varying amounts of soil contamination. For example, the waste in the bottom line of Table 8 was nearly 20 percent soil based on the dry weight of samples.

Table 9 shows the variability of some of the properties related to soil and moisture content.

Soil Contamination

The soil content was much higher than expected and was very variable. Seed cotton loaded from storage ricks on turnrows often contained visibly large pockets of soil. Table 10 shows the results of a sieving experiment on a waste sample. Passage of the fine material through the sieves was accomplished by a laboratory shaker that had a tapping action. The sieves used were conventional, soil-analysis-type sieves. A surprising amount of soil was removed, even by the 60-mesh sieve. This provided us the incentive to make further investigations into the best way to separate soil from waste, an operation needed if any industrial use is to be made of the waste but

Table 8. Turnout analysis in California (pounds per 480-lb bale)

Date		Seed Cotton		Lint		Seed		Motes		Waste	
		Wt	MC	Wt	MC	Wt	MC	Wt	MC	Wt	MC
11/9	Wet	1527	8.6	480	4.1	858	7.7	27	7.0	162	7.4
	Dry	1396		460		792		26		117	
11/11	Wet	1492	7.0	480	5.2	858	6.7	32	7.0	122	---
	Dry	1388		455		801		29		103	
11/17	Wet	1608	9.0	480	5.3	858	8.6	32	7.6	238	7.0
	Dry	1463		455		785		29		195	
12/6	Wet	1539	8.1	480	3.6	858	8.9	32	4.9	169	---
	Dry	1413		463		782		30		139	
12/9	Wet	1621	7.4	480	4.2	858	9.2	27	5.9	256	6.1
	Dry	1501		460		779		26		236	

Table 9. Properties of dry gin waste in California

Property	Range	Average
Moisture content, percent	*6.1 - 7.4*	*6.8*
Percent soil content	*8.29 - 19.68*	*12.76*
Percent noncombustible	*18.07 - 29.34*	*23.50*
Ash content of clean, dry waste in mid-South[1], percent	*6.5 - 10.2*	*8.2*
Heat value (Btu/lb)	*5385 - 6733*	*6226*
Heat value of clean, dry waste in mid-South[1], Btu/lb	*7743 - 8143[1]*	*7927*

[1] *Fuel value and ash content of ginning wastes, by A. C. Griffin, Jr. Transactions ASAE 19(1): 156-158, 167. 1976.*

Table 10. Soil and ash in waste

Sieve Mesh	% Sample Passed	% Noncomb. In Fraction	% Total Noncomb.	% Soil Passed
4	78	11	3	---
10	73	14	7	---
20	61	18	19	100
40	37	21	16	86
60	19	33	8	71
100	14	56	33	59

also one that would eliminate some incinerator problems. These investigations are now in progress.

It is conceivable that 40 pounds of soil per bale could be introduced to the incinerator. Added to that is the ash residue in the waste tissue itself. Taken together, the two could mean a residue of up to 60 pounds per bale, 1800 pounds/hour, or almost 20 tons a day for a 30 bale per hour gin. This poses a disposal problem even with incinerators that can accept fuel with a high soil-contamination level.

As originally designed, the California incinerator could not handle the soil-derived material. Instead of being carried through the system with the furnace gases to a wet-venturi scrubber, some of this material accumulated in the combustion area and in other places downstream of the combustion area. The accumulation often restricted the airflow for combustion and caused overheating. The manufacturer now believes that a solution to the problem has been found.

In the incinerator at Monette, soil contamination led to glass and clinker formation. This often restricted the airflow for combustion but was less of a problem than with the incinerator in California because the Monette incinerator was designed for ash cleanout every day. There was no provision for routine ash cleanout in the California incinerator (see Figure 2, page 17).

The soil content of the waste contributes to particulate emissions from incinerator stacks—hence the desirability of removing soil in the first place.

If soil is screened out before waste goes into the incinerator, a lot of organic material will also be removed. The screenings could be composted and should produce an excellent product. Screenings such as these are eagerly sought after by local residents at some gins we know of. Composting is dealt with by Parnell (pages 37 through 40).

Chemical Residues

Chemical residues in gin waste have been subjected to at least two studies—one at the University of California by Seiber and Winterlein[c] and the other at Texas A & M University by Miller, Hoover and Price[d]. It can safely be said that there appears to be no basis for assuming that there would be any decline in the residue content of the waste over a storage period. In fact, with decomposition, such as is found in composting or rotting, some of the residues may concentrate as the dry matter loss occurs.

The data we have on the fate of chemical residues during burning is from the University of California by Seiber[c]. He studied DEF, toxaphene and paraquat. These are reduced to almost undetectable levels in the gases or smoke coming off gin waste being burned in the open. In the same situation, Peoples[c] found very low levels of arsenic compounds. He believes that a

[c]Private communication with J. N. Seiber, W. Winterlein and A. Peoples, Dept. of Environmental Toxicology, University of California, Davis.

[d]MP-1184, Pesticide Residue in Cotton Gin Wastes, Texas A & M University and the Texas Agricultural Experiment Station. April 1975.

worker could remain directly in the combustion gases for 8-hour days without suffering any ill effects to his health. On the other hand, if particulate matter is being carried out, it is reasonable to suspect that arsenic will be carried with it and, where arsenic use is common, more research is needed.

A lot of experimenting and development is going on. We in the research area ought to do whatever we can to support and help those in the ginning industry and in the incinerator manufacturing industry to get this equipment operating satisfactorily. They have a lot of faith in it, and we at Cotton Incorporated and others in the public service areas are available any time we can be of help.

STATEMENTS FROM MANUFACTURERS

Agrotherm Los Angeles, California	Webb Nimick
Consumat Systems Richmond, Virginia	Ron Lirette
Ecology Enterprises Dadeville, Alabama	Taylor Headley
GIN-ENER-ATOR, INC. Little Rock, Arkansas	Jim Mullins
Valley Fabrication Engineers Fowler, California	Lloyd Cottrell

THE AGROTHERM GIN INCINERATOR SYSTEM

Webb Nimick, General Manager, Agrotherm, Los Angeles, California

Norman Pitt Incorporated is essentially a consultant engineering firm which, for the past 18 years, has provided special expertise in thermal processing techniques and systems engineering to a broad range of the basic industrial community. Our incinerators are based on technology developed by Norman Pitt in 1970-71; a subsidiary company, recently named Agrotherm, is now specializing in incinerator systems for producing energy from agricultural residues.

These incinerators can be roughly described as dispersion-type burners which use the principle of high velocity in the presence of excess air to achieve complete combustion in the shortest possible period of time. Figure 2, page 17, is a schematic diagram of the system.

The unit installed at Boswell's Melga Gin in Corcoran consists essentially of a 9-feet-diameter, vertical, refractory-lined cylinder with cone top, tangential inlet, an internal configuration providing a combustion zone and bottom outlet, and a propane fired burner for startup.

The incinerator requires that the waste be fed to it at a controlled rate. This is provided by a surge bin having a live bottom conveyorwith variable speed drive, which is automatically controlled by the incinerator temperature. In firing gin waste, the wide variation in characteristics, consistency and density of this material gave problems in controlling the feed until it was found that satisfactory feeding could be maintained by using a low volume material-handling fan to blow the waste into the incincerator.

The waste is suspended in an air stream as it enters the incinerator, and the hot refractory and configuration of the combustion zone cause it to ignite and burn rapidly while it travels around the chamber in a circular path. The hot combustion gases form a vortex of sufficient velocity to pneumatically convey the ashes and dirt particles out of the incinerator to a chamber beneath the heat exchanger.

The start-up burner is used to preheat the refractory and ignite the incoming waste only until the incinerator reaches the normal operating temperature range of 1500° to 1800°F. This range can be reached in less than an hour from cold startup. When operating temperature is reached, the burner shuts off automatically and the waste ignites from then on by radiation from the hot refractory.

The surge bin supplied by Boswell was designed to hold a 2-hour reserve supply of waste, which permits the incinerator to maintain operating temperature during interruptions in ginning of from a few minutes to more than an hour. If, due to insufficient supply of waste, the temperature in the incinerator declines below the normal operating range, the gas burner is automatically reignited, and then again automatically shuts off when waste feed and normal operating temperatures are reestablished.

The heat exchanger is a special channel type design, with the hot zone constructed of stainless steel materials. The hot gases from the incinerator enter the heat exchanger through the bottom at one end, exit at the other, and pass on into the wet scrubber.

A supply of clean fresh air equal to the quantity of air required by the gin dryers is blown by a fan through the heat exchanger in parallel flow. When the incinerator is at normal operating temperature, this air is heated to a range of 400° to 450°F. The heat recovery system performed exceedingly well and was able to deliver in excess of 50,000 CFM of air at these temperatures. The heat recovery rate ranged from 38 to 40 percent, about 400,000 Btu per bale.

The hot gases carry the ash and dust particles from the incinerator through the heat exchanger to a venturi-type, high-efficiency wet scrubber. Here the ash and dust particles are scrubbed out of the gases before the gases are discharged through the main draft fan and stack to atmosphere. The ashes and dust in the scrubber water drain to a settling pond, from which a pump recycles the water back to the scrubber.

The complete system consists of a surge bin with controlled feeder; the incinerator with start-up burner; the heat exchanger with clean air supply fan, and means for releasing excess heat not used by the dryers; an exhaust gas scrubber for pollution control and ash disposal; and a main draft fan. The temperature of the air entering each gin dryer is controlled automatically by a set of motorized dampers, which blend fresh air with the hot air from the heat exchanger to give the required air temperature at the dryer.

The gin waste incineration system at Boswell was designed to operate continuously, 24 hours per day, throughout the season

- to burn all of the waste produced at a ginning rate of 30 bales per hour
- to provide essentially all of the heat required by the gin dryers
- and to meet California pollution control standards.

We did not achieve all of the intended goals the first time the button was pushed. Some expected aggravations, as well as some unexpected problems, were encountered when the system was placed in operation. However, solutions for these were developed as the season progressed. One of the most severe unexpected problems was the unusually high quantity of ash. We expected the ash to range from 7 to 14 percent with an average of about 10 percent. However, tests by the Agricultural Engineering Department of the University of California at Davis showed the average was around 20 percent and at times the ash content was as high as 29 percent. After 3 or 4 days of continuous 24-hour operation, ash accumulation somewhere would necessitate a shutdown for clean-out. Nevertheless, a method was developed to move this large quantity of ash through the equipment to a point where the major part of it can be removed mechanically on a continuous basis. The rest can then be carried in the gases and removed in the scrubber.

The other unexpected problem related to performance of the scrubber. As mentioned, a high efficiency scrubber, designed by one of the most experienced and reputable firms, was purposely selected. However, during operation an emission of a very fine haze was noticeable. Additional testing revealed that this was caused by a mist entrainment problem. Appropriate modifications to correct this problem have been made to a pilot scrubber, which is now being tested on gin waste at our pilot plant in Sacramento. We expect to verify successful scrubber performance and the large unit will then be modified accordingly.

We are happy to say that by the end of the season the operating problems had been solved and the system was performing quite satisfactorily. The incinerator had no difficulty in burning the quantity of waste produced at the 30 bale per hour ginning rate. No difficulty was encountered in supplying all of the heat required by the dryers at any time while the system was operating. The gin ran smoothly and the ginners expressed a frank preference for operating on incinerator heat. With the installation of the ash removal equipment and corrections to the scrubber we are confident the system will do everything it was designed to do, and we are now ready to proceed with installations elsewhere.

This progress could not have been achieved without the excellent cooperation and assistance of the Boswell Company, particularly the management of Ginning Operations, the Engineering Staff and the gin crews at Melga.

DESCRIPTION OF CONSUMAT SYSTEMS INCINERATOR

Ron Lirette, Sales Manager, Consumat Systems, Inc., Richmond, Virginia*

Consumat Systems Incorporated manufactured the incinerator being used in the experimental work at the USDA Ginning Laboratory in Stoneville. This is described in the paper by McCaskill beginning on page 11.

Consumat Systems equipment consists of a primary combustion chamber where ignition takes place and of a secondary combustion chamber equipped with an after burner where combustion of the gases driven off from the primary chamber is completed. Auxiliary burners are used in both chambers to ensure complete combustion if prevailing temperatures are not sufficiently high. When adequate temperature levels are reached, these burners automatically shut down and the system runs pollution free on the energy it generates. Combustion chamber size depends on the hourly waste consumption required of the unit. Figure 1 is a schematic diagram of the Consumat Systems equipment. The heat-recovery section can be obtained to recover heated air as shown in the diagram or to generate steam.

The automatic feeding equipment consists of a ram, a fire door and a hopper with an opening into which the waste is fed. The arrangement ensures that excess air is not permitted to enter the starved-air primary chamber and assures desirable combustion at all times. Fuel is thus batch-fed to the primary combustion chamber with each stroke of the ram feeder.

The operation of the control system is shown schematically in Figure 1. Two stacks are provided to give the system a wide range of operational flexibility. The large stack is used to operate the equipment as an incinerator only (Figure 1, lower left). The smaller stack carries the flow when the system is producing steam or hot air (Figure 1, lower center). Partial heat extraction can be maintained by dividing the flow (Figure 1, lower right). This flow control is maintained by a patented, aerodynamic valving arrangement.

In the event of a power failure or a control failure, the system will immediately direct the hot gases through the dump stack. Once the incinerator is operating, this rapid response feature will control the system from full heat recovery to zero heat recovery in less than 10 seconds. This results in capital savings by eliminating the need for heat-dissipating devices in the heat exchanger. The aerodynamic valving also eliminates the need for mechanical valving in either stack, reducing maintenance costs.

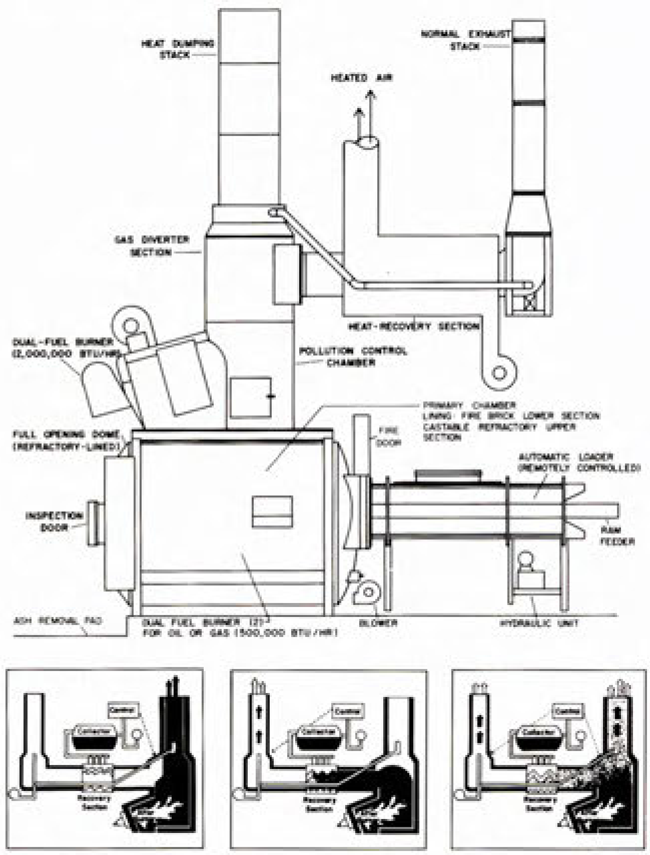

FIGURE 1. Schematic diagram of Consumat Systems equipment.

*Mr. Lirette attended the seminar and made a presentation. The information given here was written and edited by Cotton Incorporated personnel and the diagrams are taken from "Evaluation of Small Modular Incinerators in Municipal Plants" by Ross Hofmann Associates under EPA Contract No. 68-01-3171, 1976.

ECOLOGY ENTERPRISES' HEAT-RECOVERING INCINERATORS

Taylor Headley, President, Ecology Enterprises, Dadeville, Alabama

Our first cotton gin incinerator was installed 8 years ago at Drake, South Carolina. Then 3 years ago, we installed a unit in Florence, Alabama, for Mr. A. J. Buffler and, in 1975, we installed a unit at the Kiech-Shauver Gin in Monette, Arkansas. Then in 1976, we replaced the South Carolina unit with a more modern version and equipped it with heat-recovery facilities.

Our design philosophy is that the incinerator should perform maintenance free without the need to shut the gin down and that for his investment, the ginner should have a system that will operate trouble free for at least 5 years. For this reason we warrant that our systems will be trouble free for that period. We build many other types of incinerators including industrial and pathological units.

Most people are familiar by now with the incinerator concept. Cyclones separate the waste from the conveying air and feed it into the primary cell of our incinerator where combustion begins. This is a controlled-air incinerator. No auxiliary fuel is used for starting the system. The burning takes place in the primary incinerator cell and the partially burned gases pass to the secondary cell where combustion is completed. Operating temperatures are in the neighborhood of 1800-2000°F.

Particulate emission problems have been traced back to the soil content of the waste entering the incinerator. We attempt to settle out some of the particulate material in the secondary chamber and many isokinetic stack tests have shown that we are reasonably successful. Our latest installation in South Carolina yielded test data that showed particulate concentration of 0.3 grain per standard cubic foot corrected to 12 percent CO_2. This is adequate to meet the clean air standards in several states including South Carolina, Alabama, Tennessee and Mississippi.

At the Kiech-Shauver Gin, Raymond Miller, the manager, says that he saved between 85-95 percent of his gas bills in the 1975 ginning season. In 1976 there was a slight reduction in the amount of heat being recovered. We found that this was due to an accumulation of loose, spongy ash on the inside of the stack. This layer prevented heat from moving through the stack to the heat exchanger. It could be removed by sharp blows that would set up vibrations in the stainless steel stack. This could be done by striking the stack with a machine hammer one or two times a day.

The arrangement and design of the breaching and baffles in the second chamber are items covered by our patents. They accomplish separation of the particulate matter from the stack gases.

The hot stack gases pass up through the stack and the heat exchanger is in the form of a jacket around the stack. Designing the stack requires many years of experience and considerable expertise because of the thermal expansion problems that exist in some parts but not in others. Our design has now evolved to the point where we are confident that no harmful stresses due to nonuniform thermal expansion are being set up. The stack is designed to withstand wind velocities of 125 mph.

Heat passes through the wall of the stack into the air that is being pulled down through the jacket. We have an arrangement of fins to increase the heat flow through the stack into the jacket. Hot air is being pulled through the jacket by the hot air fans in the gin. We have an arrangement of valves that permits cool air to be blown into the gin to reduce the temperature of air coming off the stacks to levels appropriate for drying.

Our temperature control system is one that utilizes the existing equipment in the gin. We take signals from the gas valve modulating motor controls and use them to ensure that all the heat available from the incinerator is being used before any heat from gas is called for. This ensures that no gas is used unnecessarily and that, when more heat is needed than is available from the incinerator, the existing system in the gin will come on and operate in the normal way. We have thought about the idea of using cleaned stack gases directly in the dryers, thus eliminating the need for a heat exchanger, but we believe that this will cause deterioration of the cotton regardless of how clean the gases appear to be. We believe that the time is coming when buyers will want to know how cotton was dried. We believe that mills are going to find out that if cotton is dried with stack gases, deterioration will result that will affect their spinning operations.

We have just completed three installations in Central America and we anticipate more orders within the next few months. These three gins have annual production of 28,000, 45,000 and 55,000 bales each annually. Propane is costing 70 cents a gallon. The energy crisis is in the U. S. also even though we don't seem to realize it. The environmental people are going to have to look at energy saving systems like the ones we were talking about even though they may be environmentally marginal. If this is not done, the cotton business is going to be forced out of the United States and into foreign countries because our ginners and farmers will not be able to compete with foreigners who have no pollution laws, no OSHA regulations, and no labor laws affecting them. We are cutting our own throats.

Our system, appropriate for a 15 bale/hour gin operation would probably cost about $50,000 plus transporation and installation. We warrant this system (those parts manufactured by us) for 5 years. Electrical components are warranted for one year and we keep them in stock so that replacements are easily obtainable.

DEVELOPMENT OF THE GIN-ENER-ATOR

Jim Mullins, President, GIN-ENER-ATOR, INC., Little Rock, Arkansas

Our system is known as the GIN-ENER-ATOR. I first went to the air quality control people in Little Rock and found that there was need for a burner to destroy gin waste and to save some heat for the drying purposes. They referred me to Bill Hunter at the Murchison Gin in Coy, Arkansas. We worked out a cooperative arrangement and, with financial assistance from the air quality people in Little Rock, we undertook the development of the GIN-ENER-ATOR system.

This system is different from anything else that has been discussed here today. It is a starved-air type burner. Our first model was installed in 1975 but the unit from which it was derived was designed for burning wood waste. As a burner for ginning waste, the wood waste burner was worthless. However, we have since learned that it does a good job on wood waste and we have been able to save useful energy in that operation. A commercial version of the wood waste burner has now been installed at the Potlatch lumber plant in Stuttgart, Arkansas. The unit performs beautifully there and we believe that we have a viable unit for the wood waste application.

After the 1975 ginning season at Coy, we realized that a lot more development work had to be done. We changed the primary burner and were able to come up with a design that did a satisfactory job of burning gin waste. We also made several attempts at heat recovery by using a heat exchanger but we were never satisfied with our design. We have now more or less abandoned the heat exchanger idea in favor of using the clean stack gases directly in the drying system. This is possible because our incinerator burns so cleanly. A system using this principle is now being installed at a gin near Rector, Arkansas.

We hope to be able to market a system for a 10-12 bale/hour gin for a cost in the neighborhood of $35,000 plus installation. Our stack sampling results are discussed by Bill Hunter (page 36) and we are pleased that they are satisfactory because it gives us the opportunity to concentrate all our efforts on developing a system that will operate well with the gin.

DEVELOPMENT & TESTING THE VALLEY FABRICATION INCINERATOR SYSTEM

Lloyd Cottrell, Secretary-Treasurer, Valley Fabrication Engineers, Fowler, California

The Valley Fabrication incineration system is not yet a marketable product. We hope to have our development testing completed by the end of the 1977 ginning season and to be in a position to market our equipment after that.

Our development started during 1965 when we had a pilot model on which we ran several tests in a batch-type operation at our facility in Fowler. Prior to the 1976 ginning season, the pilot plant was scaled up to a size compatible with a 15 bale per hour gin and the equipment was installed at West Valley Cotton Growers Gin near Riverdale which is about 30 miles south of Fresno.

Our design requirements were that the equipment should be easy to start up and shut down and that it should operate without the attention of gin personnel. Our design stresses the interfacing of the incineration system with the gin in such a way that the ginning system as such is not disturbed. We do not manufacture incinerators of any other type.

Our system feeds the waste to the incinerator in a uniform manner. We designed the feed system to break the waste material down into a relatively uniform particle size.

The incinerator consists of three chambers. The first is the ignition chamber, and air entering this chamber is carefully controlled to the lowest possible volume so as to accomplish complete ignition of the material. Then after ignition is completed, the burning gases and smoke go to the second chamber where secondary air is added and combustion is completed. The added secondary air also has the function of conveying the noncombustible matter through the system. The combustion continues and is completed in the third chamber.

Hot flue gases from the third chamber are ducted to a heat-exchanger which is also a part of the primary particulate matter separation equipment. The heavy particulate is separated in a system of cyclones that also act as heat transfer surfaces to pass heat from the flue gases to the drying air being drawn into the gin. The flue gases then pass into a bag filter system which removes the fine particulate matter. The bags consist of fiberglass fabric and operate satisfactorily under the 600°F temperature of the flue gases entering them. The filter bag manufacturer assures us that the fabric should have a reasonably long life under these service conditions.

The entire unit is compact and interfaces well with the gin. We believe that we have succeeded in achieving most of our goals during our experimental work at this commercial gin in 1976.

One of our biggest difficulties arose out of the so-called clinker formation tendency. There was a buildup of material resembling volcanic rocks in parts of the unit. We are now experimenting to determine the cause of this formation and to find ways to keep the noncombustible solids moving through the system to the cyclones and bag filters that will separate them from the stack gas before it is exhausted to the air.

The cost of manufacturing and components for a 15 bale per hour system would be in the neighborhood of $100,000. In addition to this, installation would cost about $50,000.

GINNER EXPERIENCES

J. G. Boswell Company **Corcoran, California**	**John Baker**
A. J. Buffler Gin **Oakland, Alabama**	**A. J. Buffler**
Frank Murchison Gin Co. **Coy, Arkansas**	**Bill Hunter**

USER EXPERIENCE WITH THE AGROTHERM SYSTEM

John Baker, Engineer, J. G. Boswell Company, Corcoran, California

Our gin is located near Corcoran, California, and is a 30 bale/hour plant based on around-the-clock operation. I think the main reason for being involved in gin trash incineration and heat recovery, in addition to air pollution control, is the trash disposal problem and high cost of heating fuel. Natural gas is unavailable at the gin location so we use propane at a cost of 34 to 37 cents/gallon, so drying fuel costs us in excess of $1.50/bale. Trash disposal costs are around $1.00/bale making total costs for drying fuel and trash disposal of $2.50 or more per bale. If we gin 30,000 bales/year, then the economics of trash incineration with heat recovery looks fairly attractive.

This last season, we were somewhat disappointed in the number of problems encountered in operation of the incinerator, but perhaps problems should have been expected since unexplored areas are involved. Our first problem was the trash bin, which didn't do the job expected and will need to be modified for next season. This is our responsibility. Webb Nimick and his group (Norman Pitt Associates) are responsible for the burner, heat exchanger, pollution control equipment and heating air supply to the gin. The system is a little more complicated than you can see in the slide as there are three different drying systems and each one requires a modulation system to control air temperature. Last season we operated the incinerator for about 15 days total and it operated very well, furnishing all the heat necessary for drying. Interfacing between this system and the existing system appears to be no problem and can be made to work well.

Question: Did you have any problems with it getting too hot where you have to let it cool off for awhile?

Answer: The only problem with getting too hot was caused by not having the temperature controls connected and we let it get too hot. We did some damage to the heat exchanger.

Question: Does the system cost over $30,000?

Answer: We budgeted $175,000. This is for everything and we will exceed this amount before completion.

THREE YEARS' EXPERIENCE WITH A HEAT-RECOVERING INCINERATOR IN NORTH ALABAMA

A. J. Buffler, A. J. Buffler Gin, Oakland, Alabama

Taylor Headley, Ecology Enterprises, Dadeville, Alabama, installed a heat-recovering incinerator at our gin in 1974. It is a very simple unit but it works well for us.

We try to gin at about 13 bales/hour. The total fuel cost for the 1976 ginning season was 57 cents/bale, corresponding to 1.45 gallons of LP gas per bale on about 5,000 bales.

The main problem we encountered, and it developed early, had to do with cleaning out the residue from the burning. We have clinkers just as everybody else seems to have them. They were not serious problems, however, because our system is designed so that the clinkers settle to the bottom of the combustion chamber. We do not operate around the clock so that there are opportunities for the system to cool down enough so that it can be cleaned out.

We can maintain air temperatures of 120-125°F at the hot air fans. At these temperatures, we have ample drying air and when it is necessary, we use the gas burners to produce the higher temperatures that are needed for hard-to-dry cotton. We believe that the air heated by the heat-recovery system will dry cotton at lower temperatures than air heated by LP gas flame. I believe that a system like this is in the future of just about every cotton gin.

Even with our simple system, if we run continuously we need no gas to dry ordinary cotton. During the 1976 ginning season, a lot of the cotton we ginned should have gone through a wringer first. We were thus forced to use gas much of the time and this accounts for our consumption of about 1½ gallons of propane per bale. This, however, is probably less than half of what we would have had to use had we not had heat from the incinerator. After starting from cold, our system takes about an hour to reach full operating temperature.

We have about $47,000 invested in this system which is adequate for a 13 bale/hr ginning rate in our area.

LOW-COST INCINERATOR TO MEET EPA STANDARDS

Bill Hunter, Manager, Frank Murchison Gin Co., Coy, Arkansas

Ourginning rate averages about 10-11 bales/hour. There are times when we probably operate at 12-14 bales/hour for short periods. During the 1976 ginning season we did not gin 24 hours a day because we did not have the pressure of that much seed cotton on the yard at any given time. I believe that this is the first year since we have been in business that we did not have to operate around the clock.

Mr. Jim Mullins of Little Rock wanted a gin where he could experiment with his incinerator ideas and we were glad to cooperate. This experimenting has been going on for about 2 years now and finally we believe that we have a burner that can incinerate gin waste without smoke. Many visitors have been amazed at the absence of any visible plume from the stack while the gin is in full operation.

Because the incinerator as such was our primary concern, we postponed experimentation with a suitable heat exchanger.

For this reason we did not recover as much heat as we would like to have had in the gin. This should not be a difficult problem to overcome.

In common with all other incinerators we know of, we also have had the clinker problem. But by ginning for 12 hours and shutting down overnight, there was ample opportunity to clean out the system. This was satisfactory.

We believe that the soil entering the incinerator is the cause of the clinker formation. Therefore, to increase the acceptability of the system to ginners, we have designed a separation system to remove soil and to eliminate the need for daily cleanout. During a recent ginning run, we removed 17 pounds of dirt per bale ginned from the waste before it entered the incinerator. After our ginning run, we found no evidence of any clinkers in the incinerator although I do not believe the run was sufficiently long for potential problems to have had time to develop.

The incinerator definitely burns without smoke. Several tests have been run by state regulatory authorities and by private laboratories. All but one of these tests have shown that the particulate concentration in the stack gas wa well below the most stringent requirements. The one case in which we exceeded the allowable limit by a small margin was the result of a failure of the electric motor. When we started up after the problem had been repaired, sampling was begun before the incinerator reached operating temperatures and a momentary smoke emission showed up in the data. Under normal conditions, our incinerator burns cleanly within 5 to 10 minutes of startup.

In summary then, we had no problem with the burner as such. It is a good design. We did not succeed in recovering enough heat to permit drying under adverse conditions, although we were able to gin for long periods with the amount of heat we did recover. No measurements of heat recovery were made. From my point of view as a gin manager, being able to incinerate the waste without having to worry about air pollution is an achievement in itself, but we would like to be able to use the heat also. Because our unit is experimental and has been changed many times, it is difficult to state a price but we expect that a system for a 10 bale an hour gin will cost in the neighborhood of $30,000 plus installation.

METHODS OF COMPOSTING GINNING WASTE

Calvin B. Parnell, Jr.*

INTRODUCTION

More cotton is produced in Texas than in any other state in the United States. We have more gins than any other state and more gin waste than all the other states put together. Hence, this gin waste problem is particularly acute in our state. Our ginners are no longer allowed to burn waste. Many ginners in the mid-South area have received variances from state air pollution control agencies to burn waste the past few years. Our Texas ginners have not been that lucky. The Texas Air Control Board has been extremely tough on burning gin waste and it does not look like they will be less tough in the future.

Approximately 90 percent of Texas cotton is stripped. Many of the areas that are now harvesting cotton with spindle harvesters are moving toward stripping. The reasons for the conversion to stripper harvesting are harvesting cost and the speed of harvesting. Custom harvesting rates for spindle machines are $50-$60 per bale while stripper harvesting rates are $20-$25 per bale. Strippers can harvest cotton once over at a rate of three to five times that of spindle harvesters. Stripper harvesting generally results in more money in the pockets of our producers. However, stripped cotton contains a higher percentage of foreign matter. In contrast to 150 to 200 pounds of waste per bale for spindle-harvested cottons, stripped cottons contain approximately 1000 pounds per bale. We have some stripped cotton that requires in excess of 3000 pounds of seed cotton going to the gin for one 500-pound bale of lint. Waste contents of some stripped cottons can amount to 1500 to 1600 pounds per bale. Assuming a 4 million bale production in Texas in 1977, we will have approximately 2 million tons of gin waste at the gins.

The predominant method of disposing of gin waste is distributing this material over cooperating farmers' land. There are some inherent problems with this method of disposal. Disease organisms such as verticillium wilt can infect new fields that were heretofore free from this organism. Also, weed seeds such as nutgrass and field bindweed can significantly decrease future production potential. Alberson's (1) study of composting gin waste indicated that disease organisms and weed seeds were destroyed with the high moistures and temperatures associated with composting.

We initiated a pilot research project in the Agricultural Engineering Department, Texas Agricultural Experiment Station, Texas A&M University, in 1974. The objective of this work was to look at the feasibility of composting gin waste for Texas cotton ginners. If ginners could compost this material and offset some of the expenses associated with handling and disposing of this material, it could be a major savings to the cotton industry in Texas. This work was directed at answering the following questions:

(1) Could gin waste be composted by merely increasing the moisture content of the raw material to approximately 60-70 percent wet basis (WB)? If this were possible, the composting process would be simple and would require a minimum of effort on the ginner's part.

(2) What are the magnitudes of decreases in volumes and weight of the raw gin waste after it has been composted?

(3) What would be the fertilizer potential of gin-waste compost?

(4) What effect would composting have on arsenic residues?

*Cotton Ginning & Mechanization Specialist, Texas A&M University, College Station, Texas.

PROCEDURE

Six truckloads of cotton gin waste were transported from a cooperating gin to the research plots on campus. This test required that the six truckloads be placed on the ground in six different piles. Three of these piles were left alone during the composting period while the other three were mechanically aerated. All six piles were periodically sprinkled with water over a 6-week period in order to maintain the moisture content at approximately 70 percent WB.[a] Temperature measurements were made at three depths and three locations in each of the six piles per week. The three piles that were left alone were designated anaerobic while those that were turned were designated aerobic. This designation referred to the fact that the gin waste which was mechanically turned was aerated while that left alone had spots which ran out of oxygen. Lack of oxygen leads to anaerobic decomposition.

Samples of gin waste were collected periodically from each pile. Total nitrogen and arsenic concentrations were determined from these samples. Determinations of the chemical oxygen demand (COD) of the gin waste as it underwent composting were also made. Starting at the tenth week, the aerobic piles were turned and stirred for 3 consecutive weeks.

RESULTS

An average of all the recorded temperatures from the aerobic and anaerobic piles is shown in Figure 1. The temperatures rose quickly the first week after initial wetting to 120°-140°F. These temperatures gradually decreased until the tenth week. After stirring, the temperature in the aerobic piles increased to a peak of approximately 130°F and subsequently declined. This result emphasizes the need for stirring cotton gin waste for proper composting. Without stirring, there is some question whether the temperatures will be high enough to destroy the weed seed and disease organisms.

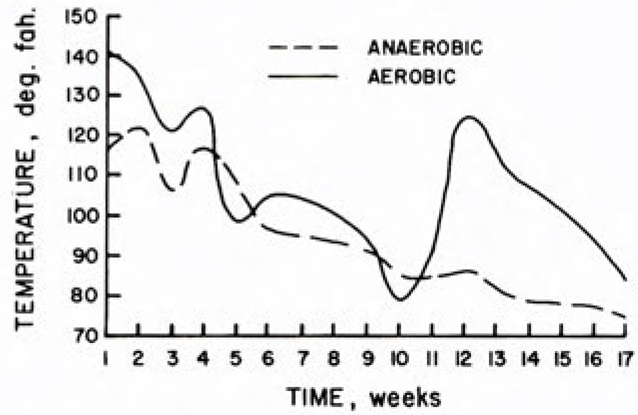

FIGURE 1. Variation of temperature with time in the anaerobic and aerobic cotton gin waste compost piles.

The mean nitrogen concentrations are listed in Table 1. These results indicate an increase of approximately 50 percent in total nitrogen in both the aerobic and anaerobic piles during the first 9 weeks. However, the stirring of aerobic piles during weeks 10, 11 and 12 resulted in an additional 50 percent increase in total nitrogen content while the aerobic piles remained the same. The final nitrogen content of the aerobic gin waste was approximately 3 percent. This would be equivalent to approximately 40 pounds of total nitrogen per ton of gin waste compost.

The chemical oxygen demand of the gin waste is shown in Table 2. It was reduced approximately 5

Table 1. Total nitrogen content (ppm) of cotton gin waste during various stages of composting

Time	Aerobic	Anaerobic
Week 0-original sample	*15,000*	*15,000*
Week 9-Prior to stirring aerobic piles	*22,650*	*23,400*
Week 17-After stirring aerobic piles	*29,250*	*23,100*

[a]Alberson's work indicated that composting requires you to raise the moisture content of gin waste to 70 percent WB.

Table 2. Chemical Oxygen Demand (ppm) of cotton gin waste during various stages of composting

Time	Aerobic	Anaerobic
Week 0-original sample	*897*	*886*
Week 9-Prior to stirring aerobic piles	*844*	*864*
Week 17-After stirring aerobic piles	*759*	*801*

percent during the first 9 weeks. After stirring, the COD of the material in the aerobic piles decreased another 10 percent while the COD of the anaerobic piles decreased 5 percent. The greater reduction in COD indicates the need for stirring or mechanically aerating gin waste during composting.

The arsenic determinations indicated an increase in concentration levels as a consequence of composting. The initial arsenic level of 193 parts per million in an aerobic pile increased to 353 parts per million. This was associated with a decrease in volume of approximately 60 percent and a decrease in dry weight of approximately 50 percent for the aerobic piles. It would seem the arsenic compound do not break down, and the reductions in volume and dry weight result in an increase in arsenic concentrations.

General observations of the final product indicate that it would not be practical to store cotton gin waste on the ground and merely add water. Anerobic decomposition takes place and odor is a problem. The anaerobic piles resulted in a material that gave off an offensive odor. The material was brown in color and much of the cotton gin waste that had not been wet by the sprinkling process had not started decomposing. In contrast, the aerobic piles contained a material that was almost black, almost odorless, and did not resemble cotton gin waste with the exception of a few sticks that had not completely broken down. The stirring seemed to have served two purposes: oxygen was supplied to the composting process, and moisture was more evenly distributed. An even distribution of the moisture is important.

Channeling was a problem in the anaerobic piles. The water would find paths through the gin waste and would not distribute itself through the material. The cotton fibers in the aerobic piles decomposed very quickly and did not present a problem.

VALUE OF COMPOST

How much return should a ginner receive for *good* gin waste compost? One figure used in 1974 by individuals selling gin waste to golf courses was $10 per cubic yard. The data in Table 3 were determined with the following assumptions:

(1) 1000 pounds gin waste per bale of stripped cotton,

(2) initial gin waste moisture content of 12 percent WB,

Table 3. Estimates of the price per cubic yard of compost equivalent to the price per ton at 40, 30, 20 and 10 percent moisture contents

	Initial M.C.	Final M.C.			
	12%	40%	30%	20%	10%
Water (lbs)	*120*	*294*	*189*	*110*	*49*
Dry Matter (lbs)	*880*	*440*	*440*	*440*	*440*
Total (lbs)	*1000*	*734*	*629*	*560*	*489*
Density (lb/ft³)	---	*27*	*23*	*21*	*18*
		Equivalent Price Per Cubic Yard of Compost			
	$30/ton	*$10.94*	*$ 9.32*	*$ 8.51*	*$ 7.29*
	$40/ton	*$14.58*	*$12.42*	*$11.34*	*$ 9.72*
	$50/ton	*$18.23*	*$15.53*	*$14.18*	*$12.15*
	$60/ton	*$21.87*	*$18.63*	*$17.01*	*$14.58*

(3) 50 percent reduction in dry weight as a consequence of aerobic decomposition,

(4) one cubic yard per bale, and

(5) final moisture content of 40, 30 and 20 percent WB.

The weight-volume equivalent price for compost is also listed in Table 3.

With the above assumptions, $10 per cubic yard would be equivalent to $32 per ton of compost at 30 percent moisture content WB. One ton of compost would have 36, 42, 48 and 54 pounds of total nitrogen for 40, 30, 20 and 10 percent moisture contents, respectively, when assuming 3 percent total nitrogen based on dry weight. Compost contains organic matter that can increase the water holding capacity of many soils. Hence its value should be much greater than the nitrogen contents alone. If the compost is sold at $12 per cubic yard ($40/ton at 30 percent MC) the value of this valuable natural resource would be approximately $48,000.000 to the Texas cotton industry.

CONCLUSIONS

It would probably be possible for a cotton ginner to compost his gin waste following the ginning season. The composting would require some mechanical means of stirring the gin waste to insure that the moisture additions would be uniformly distributed to the gin waste and provide oxygen to the composting process. The moisture content of gin waste should be approximately 60 percent. A temperature probe such as those used to detect temperatures in seed cotton modules could be used to detect a drop in temperature below 120°F and signal when the gin waste should be stirred. A front-end loader can be used to stir cotton gin waste.

The moisture content of the raw gin waste must be raised to approximately 60 percent WB. This can be done by supplying the water from the ginner's own source or waiting for a rain. Following the rain, the waste can be stirred and temperatures detected. The rain method of wetting gin waste would be the least expensive but the ginner sacrifices control over when the gin waste is composted. From our experience, approximately three good stirrings and 90 days would be required to obtain some good looking compost.

REFERENCES

(1) "Composting Cotton Gin Waste," D. M. Alberson and W. M. Hurst, United States Department of Agriculture—Agricultural Research Service, ARS 42-102, December 1964.

(2) "Composting Cotton Gin Trash," Donald L. Reddell, Calvin B. Parnell, Tom Marek, Doug Hansford, Texas Agricultural Experiment Station, Texas A&M University.

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THE MANUFACTURE OF BUILDING MATERIALS FROM GINNING WASTES[1]

Evangelos J. Biblis**

Experimental evidence indicates that it is possible to utilize cotton gin wastes (from spindle-picked cotton) in combination with wood particles and wood fibers to produce a useful product, namely insulation board, for use in housing. Utilization of these residues would be of practical significance since it could contribute to (a) reduction of disposal expenses by cotton gins, (b) conservation of our material resources for the benefit of consumers, and (c) reduction or elimination of air and land pollution caused by current disposal methods used by cotton gins.

EXPERIMENTAL WORK

Experimental work consisted of fabrication of insulation boards from various portions of cotton gin wastes, wood particles, wood fibers. The mixtures were blended with urea-formaldehyde resin and hot-pressed to ½-inch-thick boards. Boards were tested and results were compared with properties of commercial insulation boards.

Cotton gin wastes were collected from cyclones and motes from mote houses in Alabama gins. Gin wastes were dried to 6.5 percent moisture and then crushed with a hammer-mill-type animal feed grinder. Wood particles of Southern pine were obtained from a particleboard plant and hardwood fibers from a fiberboard plant. One group of boards (A) included gin waste, wood particles, and wood fibers according to the following percentages by weight for each mixture:

Component type	Group with percentage of mixture						
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Gin waste	*40*	*40*	*50*	*50*	*60*	*60*	*100*
Wood particles	*60*	*40*	*50*	*30*	*40*	*25*	*0*
Wood fibers	*0*	*20*	*0*	*20*	*0*	*15*	*0*

The other group of boards (B) included motes, gin waste, wood particles and wood fibers according to the following percentages by weight for each mixture:

Component type	Group with percentage of mixture					
	(a)	(b)	(c)	(d)	(e)	(f)
Motes	*10*	*10*	*10*	*10*	*15*	*15*
Gin waste	*40*	*40*	*50*	*50*	*55*	*65*
Wood particles	*50*	*40*	*40*	*30*	*30*	*20*
Wood fibers	*0*	*10*	*0*	*10*	*0*	*0*

Each mixture was thoroughly mixed dry in a motorized drum mixer and checked for uniformity. Urea-formaldehyde concentrate resin was used at 8 percent rate. Board mats 24 in. x 24 in. were formed and hot-pressed for 5 minutes under 400 psi at 300°F. Mechanical guards at the press guaranteed ½-inch board thickness and density of 30 lb/ft^3. Three boards were made from each mixture.

Test specimens were taken from each board and tested for flexure strength, internal bond strength, edgewise shear strength and nail withdrawal on the face, according to American Society for Testing Materials Standards D 1037-72 and D 3044-72.

RESULTS

Results of all tests are shown in Figures 1-5. Examination of results of both Groups A and B indicates that the component contributing most to board strength is wood fibers. Figure 1 shows that boards with no wood fibers (a, c, e) just meet the strength of commercial standards for fiberboard, while boards that include 15-20 percent wood fibers (b, d, f) exhibit three to four times the strength of commercial insulation board. Figure 1, Group B, indicates that inclusion of motes in the boards did not improve strength properties of the board. An explanation for this is that inclusion of motes increases the bonding area and that the spraying system for the resin perhaps was not suitable. Results in Figure 2 indicate again that wood fibers in the board improve

[1]Cotton Incorporated project No. 76-725.

**Professor, Department of Forestry, Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama

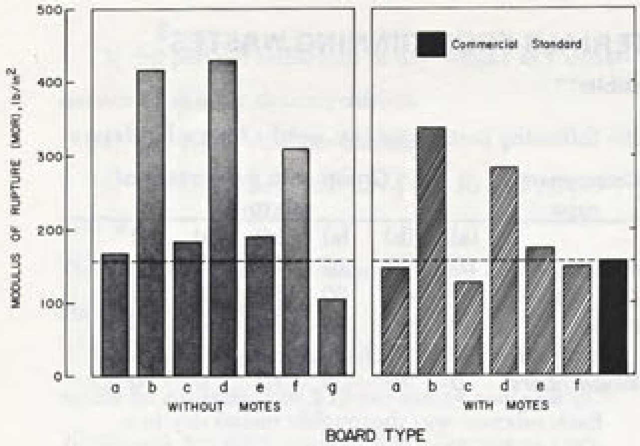

FIGURE 1. Modulus of rupture of boards made from various mixtures of cotton gin waste, hardwood fibers, pine particles, and motes.

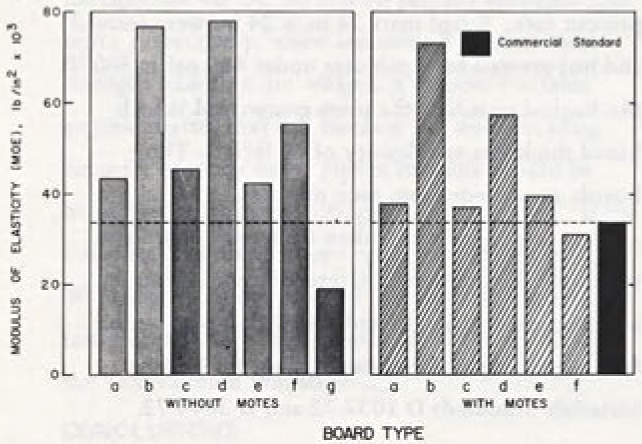

FIGURE 2. Modulus of elasticity of boards made from various mixtures of cotton gin waste, hardwood fibers, pine particles, and motes.

the stiffness of the board. Stiffness of board (g) that consisted entirely of cotton gin wastes is below the stiffness required by commercial standards for insulation board. Inclusion of motes (Group B) did not improve the stiffness of boards (a, c, e). Again, Figure 2 shows that with 15-20 percent wood fibers, the boards can surpass the requirements of commercial standards.

Figure 3 indicates the internal bond strength of all boards. Figure 3 also shows that internal bond strength of all boards, except one mixture, exceeds the commercial requirements. Figure 4 indicates that inclusion of wood fibers in boards improves the plate shear strength properties of boards. Figure 5 indicates that although wood fibers improve resistance to nail withdrawal, boards without wood fibers meet commercial standards.

In summary, the experimental results indicate that several boards utilizing 40-50 percent cotton gin wastes, some wood particles, and no wood fibers can meet requirements of commercial insulation board. It is interesting that a board (d with motes in Figures 1-5) that consists of 60 percent cotton gin wastes, 30 percent wood particles and 10 percent wood fibers is 80 percent stronger and 60 percent stiffer than commercial insulation board.

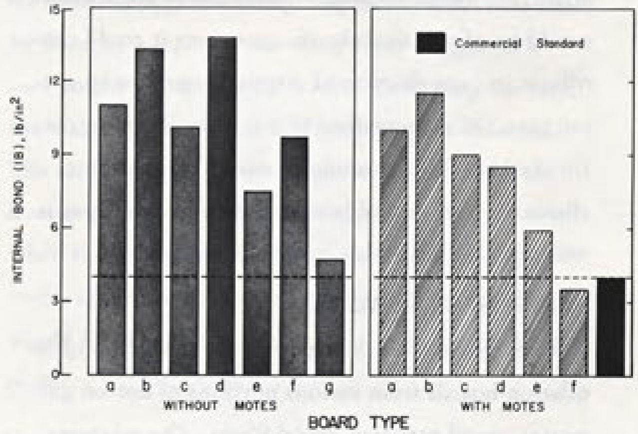

FIGURE 3. Internal bond of boards made from various mixtures of cotton gin waste, hardwood fibers, and pine particles.

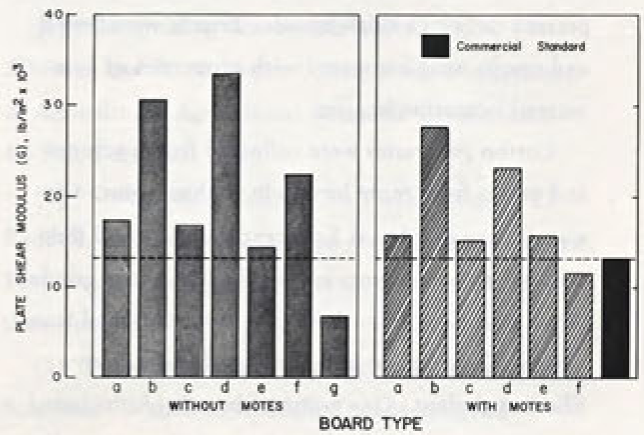

FIGURE 4. Plate shear modulus of boards made from various mixtures of cotton gin waste, hardwood fibers, pine particles, and motes.

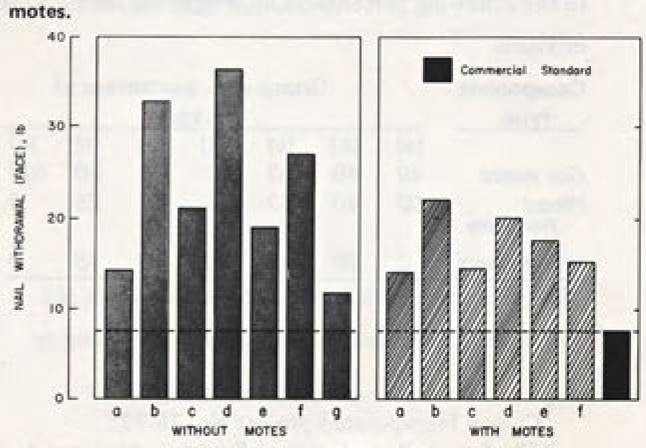

FIGURE 5. Nail-withdrawal properties of boards made from various mixtures of cotton gin waste, hardwood fibers, pine particles, and motes.

BACKGROUND AND DEVELOPMENT OF THE NEW FEEDER-CLEANER

Lambert H. Wilkes*

The Agricultural Engineering Department of the Texas Agricultural Experiment Station has had several cooperative projects with Cotton Incorporated since 1971. The first project involved the development of the module system for handling and storage of seed cotton. From 12 to 15 bales of machine-picked cotton can be stored in a 32-foot module. However, due to the trash content, only about 8 to 10 bales of stripped cotton can be stored in the 32-foot module.

No problems have been encountered in feeding the moduled cotton into the gin with the conventional pneumatic system. In fact most gins have experienced an increase in ginning rates over conventional trailers due to the fact that the cotton is more uniform in the module and the operator does not have to contend with braces and sideboards.

Since the cotton is in a uniform package in the module, it lends itself to mechanical handling. A mechanical feeder was designed and developed to feed the seed cotton into the gin. The machine consists of a series of dispersing cylinders that are used to dislodge the cotton from the mass in the module. The cotton is fed from a cross conveyor directly into the gin. The feeding rate into the gin is controlled by the speed of travel of the module into the dispersing cylinders. Field tests with the mechanical feeders showed that the ginning rate could be increased as much as 45 percent when compared with ginning machine-stripped seed cotton from trailers. The increased feeding rate was accomplished with less power and labor than was required with trailer cotton.

During the development and evaluation of the mechanical feeder, it was noted that a high degree of dispersion and separation of the trash and seed cotton occurred as the material was removed from the module by the spiked-tooth dispersing cylinders. This was further confirmed with high-speed movies made of cotton being handled by the cylinders in a laboratory model of the gin feeder.

Several designs of the conventional saw-cylinder-and-grid-bar cleaners were evaluated on the laboratory model gin feeder. In practically all cases, the trash-removal efficiency was generally higher than that which had been experienced with similar saw-to-grid arrangements used in the conventional gin cleaning system. In these studies, it was apparent that the most effective system involved: (1) the collection of the dispersed cotton on the cleaner saws as close as possible to the dispersing cylinders and (2) minimizing the amount of material per unit surface area on the cleaning saw. In order to take advantage of these features it is necessary to place a cleaning cylinder in tandem with each dispersing cylinder on the feeder. The tandem arrangement would permit a parallel flow of seed cotton through the cleaning section whereby the material could be divided among at least five cylinders in contrast to most cleaners in which the total flow is directed through a single cylinder. This, of course, required the investigation of grid bar arrangements in relation to the cylinder to permit the unusually close spacings of the cleaning saws.

Standard 14-inch-diameter saw cylinders were selected to provide maximum surface exposure to the dispersed cotton coming from the individual dispersing cylinders. The close spacings between the saw cylinders restrict the number of grid bars that can be used with each cylinder and still permit the removal of the extracted trash and the doffing of the seed cotton from the cylinder. The trash-removal effectiveness of several grid bar arrangements in relation to the saw cylinder is shown in Table 1. These data

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Table 1. Effects of Grid Bar Positions in Relation to the Saw Cylinder on Trash Removal and Seed Cotton Loss Using Machine-Stripped Cotton

Grid Bar Position in Relation to Saw Tangent	Bar Configuration	Total Trash Removed %	Total Seed Cotton Loss %
1/4" Above	*1 Bar*	*40.28*	*8.04*
1/8" Above	*1 Bar*	*47.8*	*8.78*
1/8" Above	*4 Bars*	*51.2*	*6.60*
1/4" Below	*1 Bar*	*60.0*	*8.82*
1/4" Below	*2 Bars*	*73.48*	*13.48*
7/8" Below	*1 Bar*	*63.3*	*14.22*

showed that the position of the top grid bar in relation to the horizontal tangent of the saw cylinder was more influential in total trash removal than the number of bars used per cylinder. The trash-removal efficiency increased as the bar was lowered from the horizontal tangent. Based on these data, the single-grid-bar arrangement was selected for the design of the seed cotton cleaner to be adapted to the mechanical feeder. The single-bar arrangement also permits the inclusion of saw doffing and extracted-trash removal for each of the cylinders within the limited space.

A laboratory cleaner was constructed with three cleaning cylinders. Each cylinder was positioned to accept the seed cotton from a single dispersing cylinder. The total flow of cotton from the three dispersing cylinders was fairly equally divided into each respective cleaning cylinder. Two varieties of machine stripped seed cotton and a machine-picked cotton were used to evaluate the experimental feeder. The composition of these cottons is shown in Table 2. As may be noted, the total trash content ranged from 54 percent for the machine-stripped cotton obtained from Garden City to about 6.7 percent for the picked cotton. In the laboratory tests the cottons were fed through the experimental machines at equivalent rates varying from 7 to 18 bales per hour. The dispersing cylinders on the feeder were operated at 1000 RPM and the cleaning saw cylinders were operated at 350 RPM.

The results obtained in the laboratory studies are presented in Tables 3 through 6. Approximately 50 percent of the total trash in the machine-stripped Lankart cotton was removed by the cleaner. Of the total trash, the stick content was reduced by 50 percent, and about 56.5 percent of the burs were removed. Due to the single grid bar arrangement, the fine-trash content was not reduced significantly. The effectiveness of the cleaner was not significantly changed when the feeding rate was increased from 8 to 18 bales per hour. A higher percentage of the burs and sticks were removed from the Garden City cotton. Again the rate of feeding had little effect upon the performance of the cleaner.

The seed cotton removed with the trash by the cleaner was not excessive with either type of cotton. The percent of loss, however, did increase as the feeding rate increased. These data do not represent a total loss of the seed cotton since the majority could be reclaimed from the trash.

In summary, the results of this research have shown that a cleaner can be used effectively in conjunction with a mechanical feeder. The performance of the standard, saw-cylinder-and-grid-bar system was increased significantly due to the dispersed condition of the seed cotton and to the reduced volume per unit surface area of the saw made possible by the parallel arrangement of the cleaning saws. The principles developed in the laboratory studies were incorporated in a field model cleaner. The results obtained with this machine are discussed in the following paper.

Table 2. Seed Cotton and Trash Contents of the Three Test Cottons Used in Laboratory Studies with Experimental Feeder-Cleaner

Test Cotton Designation	Seed Cotton %	Sticks %	Burs %	Fine Trash %
Garden City	46.1	8.5	32.3	13.0
Lankart	63.2	9.0	18.6	9.2
Picker	93.1	0.5	2.1	4.1

Table 3. Effectiveness of Feeder-Cleaner in Removing Trash from Machine-Stripped Lankart Seed Cotton with a Feed Rate of 8 Bales/Hour

	Components as percentage of total material			
	Seed Cotton	Sticks	Bur	Fine Trash
	Before Cleaning			
Trailer Sample	63.22	8.99	18.56	9.22
Component/Seed-Cotton Ratio		.142	.294	.146
	After Cleaning			
Feeder-Cleaner Sample	77.60	5.21	9.91	7.26
Component/Seed-Cotton Ratio		.067	.128	.094
Material Removed (Percent)	2.42	47.48	57.61	37.18

Table 4. Effectiveness of Feeder-Cleaner in Removing Trash from Machine-Stripped Lankart 57 Seed Cotton with a Feed Rate of 18 Bales/Hour

	Components as percentage of total material			
	Seed Cotton	Sticks	Bur	Fine Trash
	Before Cleaning			
Trailer Sample	61.71	8.83	20.65	8.81
Component/Seed-Cotton Ratio		.143	.334	.143
	After Cleaning			
Feeder—Cleaner Sample	75.82	5.58	10.74	7.84
Component/Seed-Cotton Ratio		.073	.142	.103
Material Removed (Percent)	3.45	50.11	56.02	29.98

Table 5. Effectiveness of Feeder-Cleaner in Removing Trash from Machine-Stripped Seed Cotton Obtained from Garden City with a Feed Rate of 7 Bales/Hour

	Components as percentage of total material			
	Seed Cotton	Sticks	Bur	Fine Trash
	Before Cleaning			
Trailer Sample	46.13	8.51	32.33	12.95
Component/Seed-Cotton Ratio		.184	.701	.281
	After Cleaning			
Feeder-Cleaner Sample	66.16	4.08	15.19	15.55
Component/Seed-Cotton Ratio		.062	.229	.235
Material Removed (Percent)	9.21	69.32	70.46	29.82

Table 6. Effectiveness of Feeder-Cleaner in Removing Trash from Machine-Stripped Seed Cotton from Garden City with a Feed Rate of 15 Bales/Hour

	Components as percentage of total material			
	Seed Cotton	Sticks	Bur	Fine Trash
		Before Cleaning		
Trailer Sample	*45.17*	*8.37*	*32.37*	*14.47*
Component/Seed-Cotton Ratio		*.185*	*.717*	*.32*
		After Cleaning		
Feeder-Cleaner Sample	*63.58*	*4.47*	*15.63*	*16.29*
Component/Seed-Cotton Ratio		*.070*	*.246*	*.256*
Material Removed (Percent)	*13.98*	*66.98*	*70.87*	*31.77*

FIELD TESTING OF A PROTOTYPE FEEDER-CLEANER

Gary L. Underbrink*

A prototype feeder-cleaner was constructed and evaluated in the field during the 1976 harvest season. Most of the field testing was done in the Texas High Plains with machine-stripped seed cotton, with the exception of some preliminary test runs that were made at the Agricultural Research Laboratory.

The prototype feeder-cleaner was constructed on a mobile chassis to aid in transporting the machine to the different areas. The basic cross-sectional features and dimensions arrived at in the experimental laboratory feeder-cleaner were incorporated into the larger machine. Standard 66-inch saw cylinders and doffing brushes were used. The use of the standard parts dictated the width of the cleaner and resulted in an overall width of 8 feet, which made it easier to transport over the highway. Five dispersing cylinders were used in the feeder, and a saw cylinder and its respective components were placed in tandem with each dispersing cylinder.

The feeding chamber is 24 feet in length and 67 inches wide. A flat wire conveyor belt was used in the bottom of the chamber to support the cotton and feed the mass into the dispersing cylinders. The feeding rate is controlled by the speed of the conveyor belt. Cotton can be dumped into the feeding chamber either directly from the harvester or with a dump-type trailer. In some cases, ricked cotton was dumped into the chamber with a fork-lift truck directly from the ricks in the field.

The seed cotton was fed from the dispersing cylinders into the cleaning saws. A standard 8-inch doffing brush was used between each dispersing cylinder and cleaning saw to assist in uniform feeding onto the saw. The cleaned seed cotton from each of the cleaning cylinders was accumulated in a sump at the rear of the cleaning section. From the sump the cotton could be picked up either by the suction fan at the gin or by a separate fan which would convey the extracted cotton into a trailer or module builder.

The trash from each cleaning cylinder was conveyed to one side of the machine with an auger. The extracted trash can be discharged from the machine onto the ground or conveyed to a reclaimer. For the prototype feeder-cleaner, the trash was discharged onto the ground and the reclaimed cotton could be discharged into the cleaned-seed-cotton sump or be kept separate.

Power was supplied to all of the components through a hydraulic transmission system. This provided a highly flexible system for research purposes by permitting the effects of varying the speeds of different components to be evaluated.

Even though the feeder-cleaner was designed basically as a mechanical feeder for a gin, the prototype

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was mobile and was used primarily in the field during the evaluation phases of development. The flexibility provided an opportunity to select different types of harvested seed cotton from differing locations.

The first extensive field tests were conducted in cooperation with Mr. Roy Faulkner of the Canyon Cotton Company which is located about 8 miles east of Lubbock. The cotton used in these studies can be broken into two major categories: (1) direct harvested and (2) rick-stored.

In the direct harvested category, three harvesting-cleaning treatments were compared. These included (1) a Hesston brush harvester that was not equipped with a field cleaner, (2) an Allis Chalmers brush harvester with a field cleaner, and (3) seed cotton harvested without a field cleaner on the stripper and processed through the feeder-cleaner. An analysis of the seed cotton from the above treatments, showing the percentages of the different components, including clean seed cotton, sticks, burs, and fine trash, is given in Table 1. The trash content was reduced significantly by using either the stripper mounted cleaner or the feeder-cleaner; however, the feeder-cleaner was more effective than the stripper-cleaner.

Further tests were conducted with the harvester-cleaner in cotton where harvesting was delayed due to hail damage, as well as in cotton produced normally without damage. The effects of the harvesting-cleaning treatments on these cottons are shown in Table 2. The gin turnout (percentage of ginned lint in harvested cotton) was considerably lower in the hail damaged cotton. The feeder-cleaner was effective in considerably increasing the lint turnout in both types of cotton by removing trash prior to ginning. About 3500 pounds of stripped cotton from the hail damaged field was required to produce a 500 pound bale of lint. This was reduced to 2146 when the cotton was processed through the feeder-cleaner, which removed about 1350 pounds of trash per bale.

Further tests were conducted with the feeder-cleaner to determine how cleaning efficiency is influenced by feeding rates. Machine-stripped seed cotton (without cleaner) which was stored in a rick was used in these tests. The effects of feeding rates on percentage of total trash, stick, bur, and fine trash

Table 1. Components as percentage of total material harvested by three methods at Canyon Cotton Co.

Component	Harvesting-Cleaning Treatments		
	Hesston Brush w/o Cleaner	A-C Brush w/Cleaner	Hesston Brush Processed through Feeder-Cleaner
Clean Seed Cotton	*57.5*	*60.1*	*69.6*
Sticks	*8.4*	*6.7*	*5.5*
Burs	*23.6*	*20.0*	*14.9*
Fine Trash	*10.5*	*13.2*	*10.0*

Table 2. Effect of harvesting-cleaning treatments on weight of harvested material per bale and on percentage lint turnout at Canyon Cotton Co.

Variable Measured	Treatment		
	Hesston Brush w/o Cleaner	A-C Brush w/Cleaner	Hesston Brush Processed through Feeder-Cleaner
		Normal Harvest	
Harvested material per bale (lb)	*2493*	*2087*	*1844*
Lint turnout (percent)	*20.05*	*23.95*	*27.11*
		Hail-damage before harvest	
Harvested material per bale (lb)	*3497*	*2475*	*2146*
Lint turnout (percent)	*14.30*	*20.20*	*23.30*

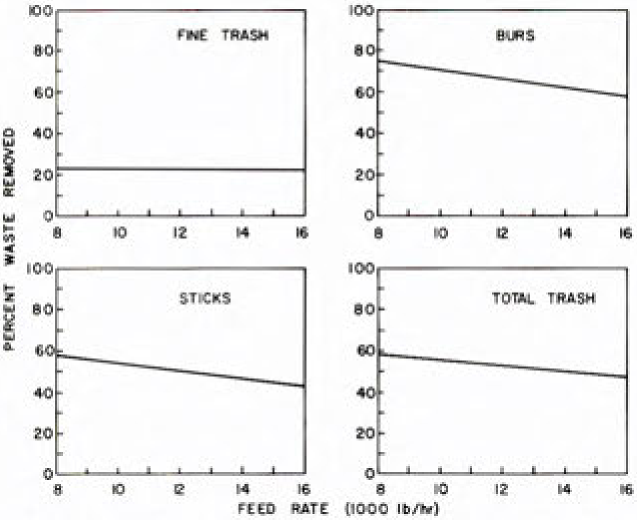

FIGURE 1. Effect of feed rate on cleaning efficiency. (Material analysis: Seed Cotton–57.46%; Sticks–8.36%; Burs–23.60%; Fine Trash–10.50%.)

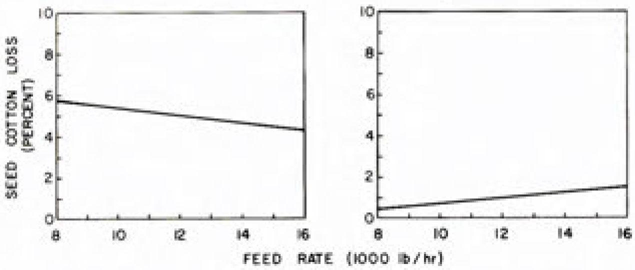

FIGURE 2. Effect of feed rate on seed cotton loss before (left) and after reclaiming; material analysis is the same as for Figure 1.

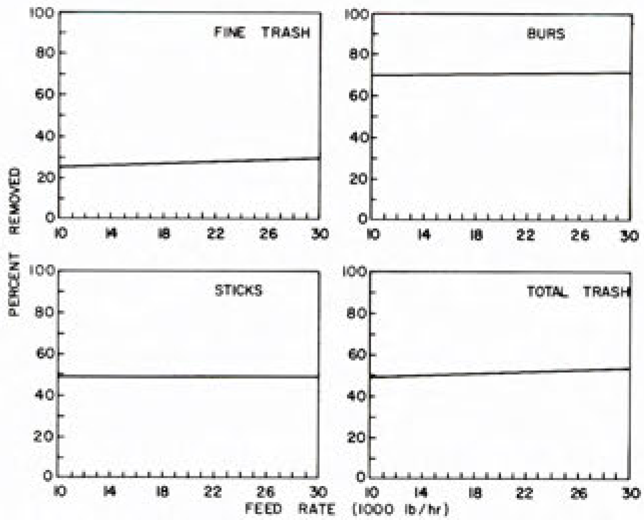

FIGURE 3. Effect of feed rate on efficiency of removing total trash and individual trash components. (Material analysis: Seed Cotton–53.7%; Sticks 10.9%; Burs–21.82%; Fine Trash–13.54%.)

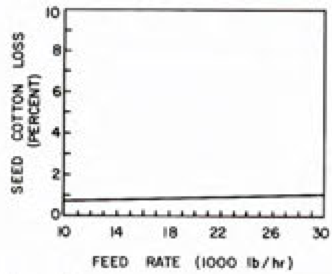

FIGURE 4. Effect of feed rate on seed-cotton loss after reclaiming; material analysis is the same as for Figure 3.

removed are shown in the graphs in Figure 1. The efficiency of stick removal decreased from about 60 percent to about 55 percent as the feed rate was increased from 9500 to 16000 pounds per hour. The bur extraction efficiency also decreased about 15 percentage points over the same range of feed rates. Since the sticks and burs made up a major portion of the total trash, this resulted in an overall reduction of 8 percent in total trash-removal efficiency as the rate of feeding increased. The seed cotton lost with the trash over the range of feeding rates is shown in Figure 2. These data were obtained from the trash before and after the reclaimer.

The tests on the performance of the feeder-cleaner were continued with ricked cotton near Crosbyton. The feed-rate range in this series of tests was increased up to 30,000 pounds per hour. Figure 3 shows that the trash-removal efficiency was not significantly affected by feed rate. The stick content in this cotton was higher than that used in the lower feed-rate studies that produced the data in Figure 1. Seed-cotton loss at high feed rates is shown in Figure 4.

Sixty-seven bales of ricked cotton were used to evaluate the feeder-cleaner as to its effect upon ginning. Thirty-three (33) bales were processed through the feeder-cleaner and thirty-four (34) bales were used as a check. The results of this study are shown in Tables 3 and 4. The gin turnout (lint percentage) was increased from 20.4 percent for the stripped cotton to 26.1 percent for the cotton processed with the feeder-cleaner, thereby reducing the amount of material that had to be transported and ginned by about 500 pounds per bale. The amount of time required for ginning was also reduced significantly.

There was very little difference in the fiber analysis and grades between the two treatments (see Table 4).

In summary, the prototype feeder-cleaner performed as well as the laboratory model cleaner. Although the prototype machine was not connected directly to a gin, the field data shows that it has sufficient capacity to handle the feeding rates required by a large majority of the medium size gins. On the average, about 50-60 percent of the total trash was removed with the cleaning saws. This represents a significant improvement over most single-saw cleaners. The stick-removal performance will vary depending upon the quantity of sticks and the physical size and characteristics of the plant material.

Table 3. The effects of the feeder-cleaner performance (Crosbyton)

Variable Measured	Treatment	
	Conventional Harvest and Gin Procedure (34 bales)	**Feeder-Cleaner Treatment (33 bales)**
Gin Turnout (percent)	*20.41*	*26.11*
Gin Run Time (minutes)	*74.67*	*64.43*
Ginning Rate (bales/hr)	*27.4*	*30.8*

Table 4. Results of fiber analysis and lint grading showing the effects of the feeder-cleaner on lint properties and grades

Measured Property	Treatment			
	Std. Harvest and Gin Procedure (34 bales)		**Feeder-Cleaner (33 bales)**	
	(Fiber Analysis)			
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**
Total Non-Lint	*3.82*	*.65*	*3.58*	*.50*
Cage Loss	*.97*	*.28*	*.86*	*.27*
Length	*1.023*	*.016*	*1.025*	*.013*
Uniformity Ratio	*76.5*	*1.02*	*75.4*	*1.09*
Gray	*55.9*	*2.81*	*57.8*	*2.39*
Yellow	*75.9*	*2.70*	*78.8*	*2.03*
	(Classer's Grades)			
34 (M Tg)	*None*		*3 bales*	
43 (SLM Sp)	*2 bales*		*None*	
44 (SLM Tg)	*28 bales*		*26 bales*	
54 (LM Tg)	*4 bales*		*4 bales*	

POSSIBLE ADAPTATION AND USAGE OF THE FEEDER-CLEANER

J. K. Jones*

Cotton Incorporated's main objective is to improve U. S. cotton for better processing performance, quality of end product and reduced cotton dust levels in textile mills. This means clean cotton. Research has shown that the lint cleaner is an effective machine to clean cotton but its use is limited by the adverse effect it can have on spinning properties of the fiber. Therefore, greater emphasis has to be placed on equipment other than lint cleaners for better and more effective cleaning of seed cotton.

The work reported by Professor Wilkes and Gary Underbrink (pages 43 to 49) demonstrates that the feeder-cleaner approach to removing large waste components from seed cotton is a new and different approach that has real potential. Not only is it an effective way of extracting waste prior to entering the gin, but it also has a low energy requirement. The idea of removing 50-60 percent (over 1,000 pounds per bale) of waste before normal gin treatments can be a great aid to areas of the Cotton Belt that are using more and more stripper-type harvesting but where gins are equipped to handle only a spindle-picked crop.

It is our thinking that, because of the high cost of pickers, the trend toward strippers will continue in traditional picker areas where yields are below a bale to the acre. What concerns us now is that growers are more or less in a trade-off between reduced stripper-harvesting cost and increased ginning cost due to the added cleaning needed. The major advantage to growers is the increase in lint per acre by using the stripper-type harvesting. Although additional evaluation is necessary to prove the total economics of this type of cleaner in the ginning system, it appears to be in the right direction to improve cleaning and to reduce energy. The value of the feeder in supplying a uniform feed rate and density of seed cotton into the gin system has been proven under commercial gin operations. Results have shown a 15-20 percent increase in production and a 10 percent reduction in electrical energy used per bale.

The advantages of combining the feeder and cleaner sections are:

(1) Keeping a high percentage of the waste and dirt out of the gin.

(2) Uniform distribution of seed cotton over large cleaning surface.

(3) Reduced effects of moisture content on cleaning efficiency.

(4) Fully opened cotton prior to gin drying and cleaning.

(5) Increased hourly production from existing gin equipment.

(6) Low energy requirements.

(7) Possibility of lowering dust levels inside the gin.

The information available may be obtained by contacting J. K. Jones, vice president and associate director, Agricultural Research Division, Cotton Incorporated, 4505 Creedmoor Road, Raleigh, NC 27612. Professor Wilkes will welcome any interested groups to College Station, Texas, to review all high-speed movie studies and other data that have been collected. We hope the industry will initiate prototype designs for the 1977 harvest.

Two areas in which we hope to do additional work are (1) the possibility of installing another cleaning cylinder to remove some of the free leaf that is still suspended in the air; and (2) developing a better means of reclaiming the small amount of seed cotton that goes over with the waste. For optimum cleaning, seed cotton losses average 4-6 percent. In retrieving the lost seed cotton, about 10 percent of the sticks are returned to the cleaned material. We believe this can be corrected.

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COTTON INCORPORATED

Cotton Incorporated is the research and marketing company of American cotton growers.

Through research Cotton Incorporated works to improve cotton fiber and cottonseed, to develop more efficient techniques for growing, harvesting, ginning and processing the crop, and to find new fiber and food products—all so that producers will enjoy the maximum net returns on their investments and labor.

Through marketing, Cotton Incorporated gives cotton farmers direct interface with cotton customers and consumers. Marketing experts and professional salesmen represent growers in the competitive marketplaces all over the world in efforts to create new markets for cotton products, and thus to create increased demand for cotton fiber and other products.

Cotton Incorporated represents only the interests of American cotton producers. Cotton producers only sit on the board of directors, elected by cotton producer organizations in the 19 states in which American upland cotton is grown.

Cotton producers guide and govern the operations of Cotton Incorporated, and cotton producers fund the company's operations through a voluntary contribution for every bale of cotton sold.

Sales-marketing activities are centered in New York City, where agents of cotton growers work directly with the mills that spin, weave, knit, dye, print, and finish cotton, with the manufacturers that make wearing apparel and other consumer products from cotton cloth, and with mass volume chain stores and independent shops that sell cotton products to consumers.

In addition, the sales-marketing division operates "Cottonworks" facilities in New York, Dallas and Los Angeles. In these private showrooms, manufacturers and fashion designers can choose in privacy the latest cotton fabrics offered by American mills.

At the Cotton Incorporated Research Center at Raleigh, N. C., three research divisions work to improve the quality and marketability of cotton fiber and cottonseed products.

The textile research and development division explores new fabric constructions and finishes in efforts to develop new and profitable products for the industries that consume cotton fiber.

In economic research and development, economists, marketing men and computer scientists seek techniques for marketing cotton that will bring equilibrium to factors affecting supply and demand so that cotton producers and cotton customers alike can earn maximum profits.

In agricultural research, scientists in many disciplines conduct research on new and improved cotton varieties, on more efficient production systems, and on more effective insect, disease and weed controls. Engineers look for ways of applying modern technology to the harvesting, handling, ginning and processing operations.

Agricultural research scientists and engineers seek to make cotton a true agro-industrial product, not subject to the vagaries of pestilence and weather. The primary objective always is to give the producer the highest possible profit for every acre he plants to cotton.

This agro-industrial report contains the findings in one agricultural research area.

The more cotton the better

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