Status of Efforts by Oil Mill Machinery Manufacturers to Control Fugitive Dust Emissions

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ABSTRACT

Machinery manufacturers who serve the cottonseed crushing industry are fully aware of the existing fugitive dust problems. The main problem lies in the unique characteristic of cottonseed as being a non-free-flowing material until after lint removal. This characteristic is compounded by varying degrees of moisture. Therefore, a totally enclosed cottonseed cleaner in a dust-tight shroud is not practical due to periodic choke-ups, tail-over from the top trays and the frequent necessity to manually clean the screens. Delintering equipment has been successfully equipped with canvas drapes connecting the feeder to the top of the roll box front as well as hinged doors that connect the black seed chutes to the bottom of the roll box. Dust and noise levels have been reduced, but not eliminated. Rock and shale traps between the white seed tank and cleaning rooms, as well as within the lint rooms and separating rooms, help reduce free-fly lint within the processing streams. Rock and shale traps that operate under positive pressure can be another potential dust source which can be eliminated by a dual fan arrangement. After delintering, cottonseed becomes more predictable with regard to flowing ability and more conventional methods of dust control can be applied. Separators can be enclosed as long as maintenance accessibility and operator control visibility are not hindered. The operating air requirements for the machine can be used to maintain an air flow into the enclosure, thus greatly reducing dusty emissions.

INTRODUCTION

The control of fugitive dust in cottonseed processing equipment is by no means a simple task of applying proven methods of dust control that have been successful in other oilseed industries. The reason lies in the unique characteristic of cottonseed that is semi-free-flowing sometimes and non-free-flowing at other times. The seed has a tendency to mat (or stick together) when wet (above 13% moisture) or after being compacted by its own weight in storage. It bridges easily and catches fire from the smallest of sparks. The lint surrounding the seed has the ability to capture everything from submicron dust to pea-size rocks and carry them with the seed into the processing areas. Loose, or "fly" lint, is created every time the seed is handled, i.e., from the truck dump, conveying systems and processing equipment. These characteristics present quite a challenge to machinery manufacturers in trying to control fugitive dust, especially should rigid dust standards be enacted.

The areas of primary concern to OSHA (respiratory dust) and EPA (outside environment) are difficult to separate in a cottonseed oil mill due to the large quantity of air required for the processing equipment. Roughly 19,030 m^3 (672,000 ft^3) of air is necessary to process 907 kg (one short ton) of cottonseed through conventional equipment. In other words, a 272,109 kg/day (300 short ton/day) plant takes in 3,965 m^3/min (140,000 CFM) of air. Thus, the inside processing area will only be as clean as the outside air source. If machinery manufacturers or users try to reduce or eliminate the process air, a totally new set of process problems is originated.

EMISSION SOURCES AND POTENTIAL SOLUTIONS

Seed Receiving

The first area of concern is the truck dump where seed is received. Dust control measures that have been applied to some dumps consist of an air manifold arrangement installed around the top periphery of the dump pit with several branch lines that extend down into the adjoining conveying pit. A large quantity of air is drawn through this manifold with a fan that discharges into a cyclone collector or bag filter. The system works very well on free-flowing grains and seeds in controlling the dust, but only fairly well on cottonseed. The operator can control the rate of discharge into the pit on free-flowing seeds, but loses this control on cottonseed. As the truck is lifted, the cottonseed breaks loose in large chunks. Sometimes the load remains inside the trailer until the dump is above 35-40°, and then a mass of seed that might weigh 4,537-9,074 kg (5-10 tons) breaks loose. This avalanche of seed sometimes occurs even with a skilled operator who tries to lift the truck in stages. When such a mass of seed hits the bottom of the pit, no vacuum system can capture all the dust-laden air that is displaced. A vacuum system helps to reduce the dust level in the truck dump area and should be considered. The seed in the next truck may flow from the trailer in a more orderly manner. This unpredictable amount of emissions at the dump presents a problem unique to the cottonseed industry. Several mills have built enclosed operator stations close to the wheel chocks or backstops with good visibility of both the pit area and truck platform. Isolating the operator from the emissions is an acceptable administrative practice, but does nothing to control fugitive dust.

Seed Storage and Reclaim

The next area of concern is the reclaim system where the seed is removed from long-term storage and conveyed into the mill. Above the typical seed tunnel, the seed are stacked from 18-31 m (45-80 ft), depending on the width of the seed house. The lower side boards are removed and the seed must be manually fed onto the reclaim drag belt. Most of the seed can be reclaimed in this way and the remainder from outside the tunnel by use of a portable conveyor or front-end loader. The use of air-conditioned cabs on front-end loaders and well-ventilated seed tunnels may help, but the dust problem remains.

Seed Cleaning

From reclaim, the white cottonseed is sent to the cleaning rooms via scalpers designed to remove any large foreign matter that could damage both conveying and process equipment. Sometimes "sand and boll reels" serve the same purpose while also removing fine dirt and trash. The cleaner is the first piece of process equipment in which the removal of all foreign matter (unginned cotton, large sticks and burrs, twigs and leaf shale, large and small rocks, sand, immature seeds, fly lint and dust, black seed and meats, as well as a great variety of other contaminants) is attempted. Unfortunately, many mills gauge the capacity of their cleaners by how much seed they can pass through the top trays without tail-over instead of the quantity of foreign material contained in the cottonseed. Figure 1 shows the flow of seed as it passes through a Bauer #299, 4-tray cleaner. The arrows point to 7 areas where fugitive dust emissions can occur. The best method to control fugitive dust from cleaners is under active investigation by many

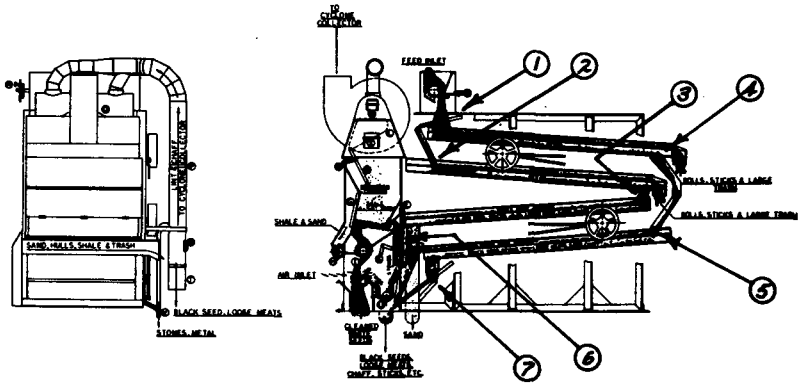

FIG. 1. Fugitive dust points on a Bauer 299 cleaner.

firms. Our company is investigating and evaluating several possibilities for cleaner dust control and hopes to offer additional dust control features for new equipment, as well as retrofit kits for existing Bauer cleaners, in the near future.

The ultimate dust control devices must not hinder any of the operating functions of the cleaner. They must leave maintenance points and all control points clearly visible and easily accessible. The dust control devices must be effective, reliable, as free of maintenance as possible and economical. For example, the 4-tray Bauer cleaner has 7 points from which fugitive dust can be emitted. The concept of the 4-tray cleaner originated in the 1950s to yield better cleaning results, not more capacity. During the 1960s, many oil mills closed because of, e.g., unavailability of seed locally and the retirement of independent owners. The remaining oil mills were forced to expand and looked to the 4-tray cleaner as a means to increase capacity economically. The higher capacity concept, not better cleaning results, still exists in the industry.

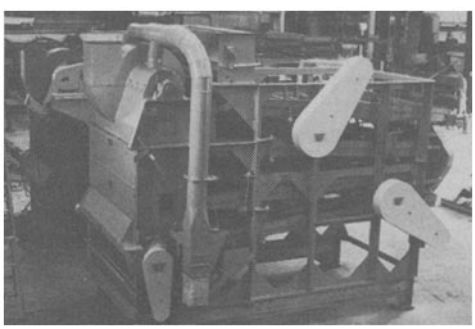

FIG. 2. Four-tray cleaner with totally enclosed safety guards.

Figure 2 illustrates a new 4-tray cleaner. The cleaner is fully equipped with totally enclosed safety guards. Little room is left for the addition of more peripheral equipment. The machine is completely open and gives the operator free access to control points as well as good visibility to spot potential maintenance points before a breakdown or a choke-up occurs. As shown in Figure 3, the 2-tray cleaner has only 3 points of possible fugitive dust: where the seed drops onto the first tray under the feeder, where the seed drops onto the second tray and where the trash fraction is discharged from the lower tray. No fugitive dust should be emitted from the intake chute of the lower fan hood because of the large quantity of air drawn in with the seed. Both the 4-tray and 2-tray cleaners require about 142 m^3/min (5,000 ft^3/min) of process air to function properly. Most of this air enters the front of the lower fan hood: an estimated 28-42 m^3/min (1,000-1,500 ft^3/min) enters the intake chute with the seed and a smaller quantity enters from the secondary recovery moting chamber. The additional use of this process air for fugitive dust control is under investigation. Care must be exercised to avoid adversely affecting machine operation.

Delintering

The cottonseed oil mill industry uses both 31.7- and 45.7-cm (12.5- and 18-in.) diameter saw delinters equipped

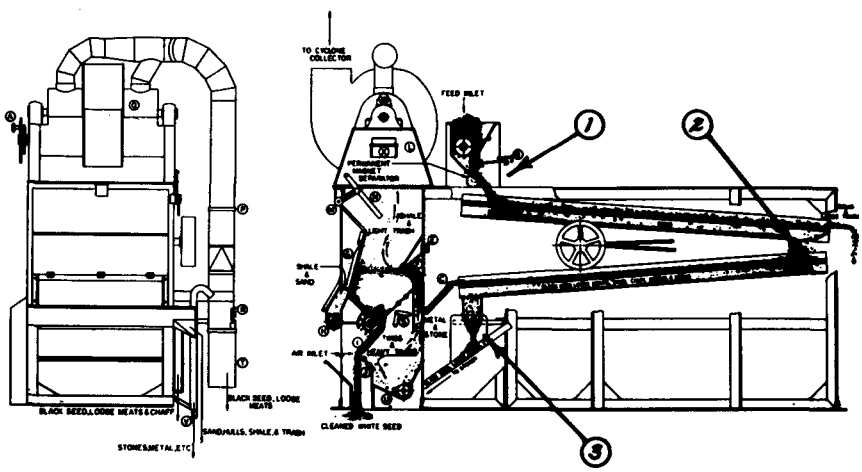

FIG. 3. Fugitive dust points on Bauer 199 cleaner.

with brushes or brushless attachments. Saw delinters of either size require frequent maintenance. Dull saw cylinders must be removed from the delinter and be replaced by a newly sharpened cylinder. This maintenance procedure generally is required every 24 hr or even as frequently as every 8 hr of operation. The saw delinter has been designed to that the operator can accomplish this task as rapidly and accurately as possible. The feasibility of attempting to seal off completely every dust emission point on a saw delinter would be very hard to justify. On the other hand, many mills have attempted to control the more obvious fugitive dust points between the feeder and roll box front and between the gratefall and black seed chute using canvas drapes, hinged sheet metal doors or clear acrylic doors. These devices work very well as long as the operators keep them closed. Because these doors are very simple devices that can be easily fabricated on a local basis, equipment manufacturers have chosen not to offer them as standards on new equipment.

The abrasive delinters in some mills do not require as frequent maintenance as the saw delinter and, consequently, can be "buttoned up" tighter. However, the abrasive delinter creates more fine respirable dust during the delinting operation that could contribute to a fugitive dust problem downstream in the lint cleaning rooms, bale press rooms, and even in the hulling and separating rooms.

Hulling and Separating

After delintering, cottonseed flowing ability becomes more predictable and, thus, more conventional methods of dust control can be applied. The black seed, which still contain 2-4% residual lint, is conveyed to the hulling and separating rooms via black seed tanks, safety shakers, rock-and-shale traps and magnetic separators. The rock-and-shale trap (Fig. 4) has long been a potential source of fugitive dust and, for this reason, is usually installed outdoors. Most rock-and-shale traps are equipped with one blow-through fan which maintains a positive pressure inside the aspiration chamber and the connected screw conveyor. By equipping the aspiration chamber with a dual-fan arrangement, as shown in Figure 4, the chamber can be maintained at zero or slightly negative pressure. The dual-fan system requires the same operating power as the conventional single-fan system, eliminates the dust problem and does not require a separate by-pass conveyor in case of a choke-up. This arrangement has proven successful in the field and has been offered for several years. Existing rock-and-shale traps can be easily converted in the field to a dual-fan arrangement.

New dust-tight features on the Chandler huller became available in 1979. The darkened areas in Figure 5 were added in an effort to control fugitive dust. All Chandler hullers that have been manufactured since that time incorporate these features, with exception of the tramp metal catch box located under the safety levers. The catch box is necessary to control the dust that is forced out between the safety levers. Briefly, the new dust-tight features include: (a) both front and back doors have been redesigned and sealed with polyurethane foam strips; (b) the feeder is assembled with foam strips between the front, back and end pieces; (c) the space between the feeder and safety levers has been sealed with a strip of neoprene rubber; (d) the safety levers now seat on polyurethane foam instead of the rough casting of the front breast girt; (e) the space between the front door and breast girt has been sealed with a neoprene rubber loop which allows the breast to move up or down while maintaining contact with the seal; (f) packing has been placed under the bearing housing; and (g) an easily removable tramp metal catch box has been added under the safety lever discharge point. This drawing,

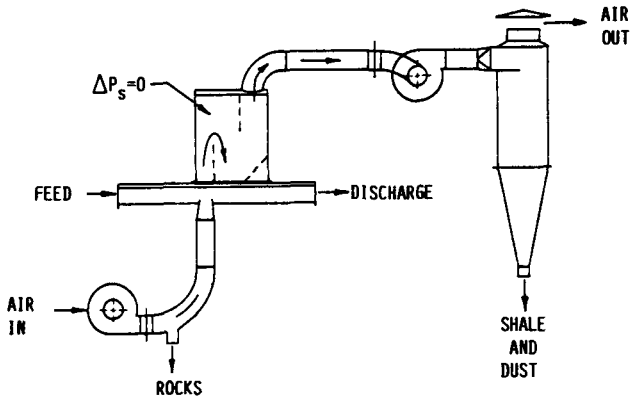

FIG. 4. Rock and shale trap.

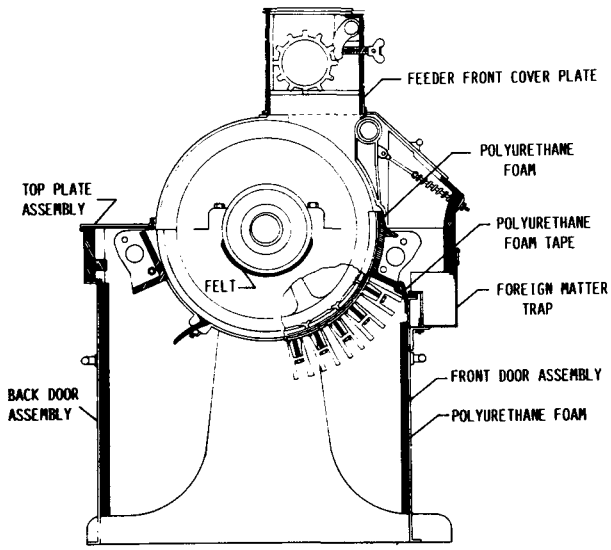

FIG. 5. Modifications to Chandler huller for dust emission control.

complete with a detailed bill-of-materials, is available upon request.

The huller mounts directly on top of the separator. Figure 6 shows the Bauer 403 separator-purifier. The transition point between the huller and top tray of the separator (Fig. 7) has always been a fugitive dust point. By equipping the metal deflectors with canvas loops and drapes (Fig. 8) that come as close to the first screen as possible without touching, most of the dust will be confined to the tray. Note that the ends of each curtain are equipped with a metal strip, which helps prevent fraying of the canvas and helps hold it in place. The older model 403 separators were furnished with only metal deflectors that did not extend to the screen because that would hinder sash removal.

The separator can be totally enclosed with a metal shroud equipped with access doors and louvered vents for process air to enter. This approach certainly solves the fugitive dust problem defined by OSHA, but disregards the sanitary guides of the FDA. Caution must be exercised not to over-react to solve one problem and create another.

There does not seem to be much of a problem with dust emissions from hull beaters or tailings beaters currently on the market provided the covers and doors are properly maintained and kept securely fastened. Unfortunately, the doors must be opened periodically and the screens cleaned manually. This exposes the operator to large quantities of

fugitive dust. Only recently have the Bauer 408 hull beater and 409 tailings beater been equipped with a high-pressure manifold that allows the operator to clean the revolving cylinder screens without opening any doors. The operator simply opens an air valve for 15-20 sec. This cleaning method is expected to generate some fugitive dust. This approach is better than exposing the operator for up to 15-20 min as was formerly necessary. Most of the dust should be confined inside the beater. The purifying nozzle on the discharge end of the hull beater will have to be used to help capture some of the dust-laden air before this internal blow-down occurs. The dust curtain that hangs in front can easily be modified to include the purifying nozzle to fully utilize this process air for dust control.

FIG. 6. Bauer 403 separator-purifier.

Lint Cleaning

In lint-cleaning rooms, newer equipment is considerably more dust-tight than are the older machines. However, the manufacturer is faced with the dilemma of how to maintain a dust-tight machine which is subject to lint fires. Lint-room fires that carry over to the lint beaters and sometimes even to the bale-press rooms are not common on a weekly or monthly basis, but can be expected from time to time. These smoldering fires will destroy synthetic seals and warp sheet metal doors and enclosures. Lint cleaners must have quick-opening and easily accessible doors and covers not only for cleaning and maintenance purposes, but so that these periodic fires can be extinguished rapidly. Because every door and cover is a potential fugitive dust point, the problem facing the manufacturer in constructing an air-tight lint cleaner is formidable.

FIG. 7. Transition between huller and top tray of separator.

The dust problem in cottonseed oil mills will not be solved with only dust-tight processing equipment; a systems engineering approach to the complete plant is required. Modifications to new equipment will not help existing oil mills. The manufacturer is not only concerned with marketing equipment designed to perform a specific task, but also with the performance, reliability and economy of that equipment in relation to OSHA, EPA and FDA guidelines and specifications.

FIG. 8. Canvas drapes on first separator screen for fugitive dust control.