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Engineering Success

A newsletter from Biosystems and Ag Engineering Extension

Grain bin entrapment prevention

By: Carol L. Jones, Biosystems and Ag Engineering

As the current crop is harvested and grain in storage is moved from bin to bin or to truck for sale, chances for grain bin accidents and injuries increase. Now is the time to consider the causes, steps for prevention, and how to respond if an accident does occur.

Know How It Can Happen and Preventive Measures

Three of the most common ways people become trapped in grain include the movement of grain during unloading. Elevator employees and producers that store grain on farm should be aware of the ways people become entrapped, how to prevent it and what to do if it happens.

1. Collapse of a grain bridge

Grain bridges form when the top surface of the grain becomes moldy or frozen. A cavity forms below the crusted surface when grain is unloaded. As a worker attempts to walk across the top surface of the grain, the added weight causes the crust to collapse. The worker could be partially or completely buried in the grain instantly (figure 1). Not only can the worker be covered, but the grain also may move him several feet from the initial breakthrough at the surface. This complicates rescue efforts because it may be difficult to locate the engulfed worker.

Prevention:

- Inspect the top surface of the grain before placing weight on the grain surface. If grain has been unloaded, an inverted cone should appear at the top surface and the grain surface should look shiny. If it does not, grain has not moved at the stop surface and a bridge may have formed underneath.
- Do NOT stand on the grain surface!
- Using a pole, probe the top surface to break the bridge and free the grain. Do this from the bin roof hatch or from the inside ladder while tied securely to the ladder
- Always carry a pole when entering bins to probe for bridge caverns and for stability if a worker is caught in grain flow
- Proper management of grain helps to avoid the conditions that cause bridging and poor grain quality

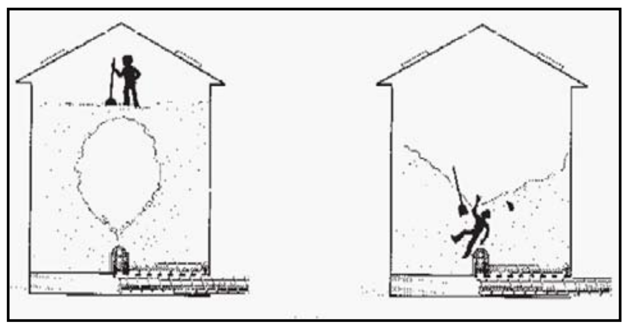

Figure 1. Although grain appears firm enough to walk on, grain can form a hard crusted top surface with a cavity underneath caused during unloading. The crusted surface can break and instantly bury an individual in the hollow cavity underneath the surface.

2. Avalanche of a vertical grain wall

Grain that has gone out of condition may form large columns or piles of grain caked against the bin wall. This column may break free due to poking with a stick or shovel or from something as simple as vibration. The grain may then completely engulf the worker that has entered the bin. (figure 2).

Prevention:

- Stay above the highest part of the grain column
- Work from top to bottom to dislodge the grain stuck to the wall
- Use a body harness and safety rope to securely tie off
- Be aware at all times that the entire grain wall can collapse
- Proper management of grain helps to avoid the conditions that cause grain to stick to walls and form these columns

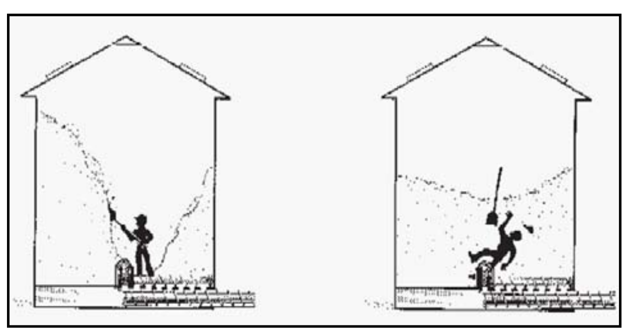

Figure 2. A steep wall of grain can break free and cause an avalanche that could bury workers inside the bin

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Grain bin entrapment prevention

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3. Flowing grain

A funnel of grain develops as grain flows downward from the top center to the bottom of the bin during unloading. This funnel is caused by the auger at the bottom of the bin transporting grain outside the bin. A worker standing on the grain surface can become helplessly entrapped in the grain in only two to three seconds. These same conditions can also happen inside a gravity wagon. Much like quick sand, the grain can pull the worker under and cause suffocation (figure 3).

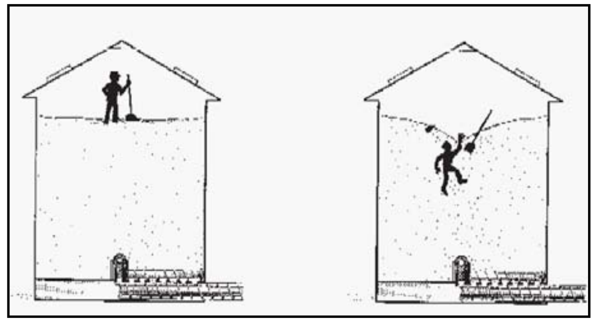

Figure 3. As an unloading auger draws grain from the top center forming a cone at the top surface, entrapment can occur quickly.

Prevention:

- All bin entrances and gravity wagons should have warning decals
- Secure storage areas to prevent unauthorized bin entry
- The bin should be equipped with a permanent life-line rope hanging down the center of the bin with knots tied every few feet. This allows a person trapped in the flowing grain to grab on to the rope in hopes of stabilizing himself
- Warn all workers, visitors, and family members of the dangers
- Before entering a bin, use "lock-out/tag-out" procedures to turn off and lock conveyor power controls

Grain bin rescue procedures: For producers or elevator personnel

1. Auger and all unloading equipment must be shut off and locked out (lock out/tag out).
2. Contact an emergency rescue team or fire department.
3. Use an aeration system to ventilate the bin if possible.

For Rescue Team

4. Prevent additional pressure on and around the victim.
   a. Stay away from the area immediately around the victim.
   b. Use a ladder, plywood, or other material to distribute weight.
   c. Keep unnecessary personnel out of the grain bin.
5. Protect rescuers.
   a. Attach safety lines to rescuers.
   b. Use respiratory protection as required; i.e., dust filter masks, filter respirators, or SCBA.
6. Construct a retaining wall around the victim.
   a. Use plywood, sheet metal, or large trash cans with the bottoms removed to keep grain away from the victim, particularly around the chest and head.
   b. You may need a series of retaining walls braced to prevent collapse.
7. Remove grain inside the retaining wall and away from around the victim.
   a. Don't try to pull the victim with a line and harness before removing the grain (hoist or block and tackle removal can cause serious injury). Attaching a harness to the victim will help prevent further submersion in the grain, however.
   b. Use a vacuum or scoop to remove grain from around victim.
   c. To avoid further injury, care should be taken to avoid parts of the victim covered by grain and not visible. Be careful when parts of the victim are not visible.
8. Drain grain from bin by cutting holes in the walls.
   a. If the victim is completely submersed, do this immediately.
   b. Cut at least two U-shaped or V-shaped holes on opposite sides; three to four holes symmetrically spaced are recommended. More holes can be cut for large bins.
   d. Do not cut across vertical or horizontal bin sheet joints. Make a cut about 30 to 40 inches across between the bolt lines of a single sheet.
   e. Locate holes just below the feet of a partially submerged victim or as low as possible if victim is not visible.
   f. Air chisels, power saws, tractor loader, or cutting torches may be used to cut holes.
   g. Uniformly drain the grain from two, three, or four holes around the bin.
9. Provide care for the victim.
   a. Using oxygen or SCBA, assist the victim's breathing.
   b. Maintain body temperature with saline plasma I.V. or other means.
   c. Communicate with the patient about his/her condition and the rescue activities taking place.
   d. Plan ahead for removal of the patient from the bin.
10. Victims have survived complete burial in grain for two hours. Therefore, be patient and don't give up.

For More information see Oklahoma State University Extension Fact Sheet CR-1726 Grain Bin Entrapment: What If It Happens To You?

For more information on grain bin safety, contact the Oklahoma State University Department of Biosystems and Agricultural Engineering at 405-744-5427.

Energy from biomass: The case for anaerobic digestion

By: Doug Hamilton, Extension Waste Management Specialist

Much of the media coverage of renewable energy is focused on motor fuels such as ethanol and biodiesel. Other pathways to energy independence sometimes get lost in the shuffle. One of these alternative processes is anaerobic digestion.

Anaerobic digestion is conversion of organic matter to biogas. Biogas is a mixture of carbon dioxide and methane. Methane is flammable. We can burn it and use the heat directly, send it to an engine-generator to produce electrical energy, or compress it to run natural gas powered vehicles.

Biogas digestion and ethanol fermentation both convert biomass to energy at roughly the same efficiency. Forty to fifty percent of the energy stored in biomass is converted to useable energy — whether we convert it to ethanol or methane. The main advantage of anaerobic digestion is that it uses proven technology. Anaerobic digestion has been used in sewage treatment since the late 1800s. The federal government put lots of resources into anaerobic digestion of animal manure in the 1970s and early 1980s. Now that the price of energy is increasing, much of the technology developed in the 80s can be put into practice.

Thirty years ago, the emphasis was producing biogas from manure, but nearly all organic material can be converted to methane. Even if we add a small amount of carbon to manure and it will produce even greater amounts of biogas. The Europeans have been doing this for several years. First, the Germans started mixing wheat and corn silage with dairy manure. Now, the Irish are doing the same with ensiled grass. A group of investors in Texas are looking into anaerobic digestion of sorghum silage. Dairy farmers in New York add food scraps from restaurants to boost gas production in their digesters. Glycerol, a by-product of biodiesel production, is rich in energy and has high methane conversion efficiency – nearly 80 percent.

Although we can compress methane to run motor vehicles, it is more common to use biogas as a source of on-farm power. Cogeneration (or combined heat and power) systems use an engine-generator burning digester gas to produce electricity. The heat given off by the engine is used to warm the digester. Extra heat is available wherever it is needed on the farm.

A survey conducted by Texas A&M University showed that anaerobic digestion of manure could replace 100 percent of the electricity used by free-stall dairies in Central Texas. The Winrock Foundation, using a very inefficient covered lagoon digester, demonstrated that biogas could replace 50 percent of the energy used on a swine farm in Arkansas. Even if only 50 percent of the electricity was produced on-farm, using manure power during peak periods would greatly reduce energy costs.

Addition of high carbon materials to manure digesters could possibly switch swine and dairy farms from energy consumers to energy producers.

For more information see the extension fact sheet, BAE 1747 Anaerobic Digestion of Animal Manure: Understanding the Basic Processes, available through your local extension office or by following the links at http://osuwastemanage.bae.okstate.edu.

Also check out the national eXtension anaerobic digestion web site at http://www.extension.org/pages/Manure_Treatment_Technology_Articles.

Anaerobic digester producing biogas from swine manure at the OSU Swine Research and Education Center.

GPS accuracy for guidance systems

By: Randy Taylor, Extension Ag Engineer, Machinery Systems

Accuracy should be understood when discussing global positioning system (GPS) based guidance systems. Performance of a GPS receiver can be considered in two ways, accuracy and precision. Accuracy is defined by how well the receiver can locate itself on the face of the earth. This is more important when you want the capability to return to an exact location at some time in the future. Precision is determined by the consistency or repeatability of the receiver. Precision for GPS guidance systems is typically reported in terms of pass-to-pass error. A more precise system will have a lower pass-to-pass error.

In general, guidance systems can be broken into three categories based on GPS accuracy. A real time kinematic (RTK) GPS system is the most precise and accurate. RTK systems offer sub-inch pass-to-pass precision and very repeatable accuracy. Systems are the most expensive and require a base station. Multiple vehicles can use a signal from the same base station as long as they are within range of the radio signal. Operation requires line of sight so typical ranges of operation will vary with terrain, but are usually less than 6-8 miles. It is possible to set up repeater stations to extend the range of the radio signal. Since multiple vehicles can operate with the same base station, the cost of RTK systems can be spread over many users. There have even been RTK networks set up that cover many miles. These networks allow users to have RTK accuracy with wide area GPS mobility.

The second category contains receivers capable of providing pass-to-pass accuracy less than 4 inches. These are dual frequency GPS receivers that require a subscription signal for differential correction. The cost of the signal varies with provider. Since there is no base station, these systems have a wider range of operation. Though the pass-to-pass precision is good, they are not as accurate or repeatable as RTK systems. However, advances in differential correction techniques are improving the accuracy of dual frequency receivers and these receivers can now be used for tasks that previously required RTK systems.

The third category offers pass-to-pass precision of about 8-10 inches. These are typically powered by GPS receivers that are using a single frequency differential correction from a subscription provider or the FAA's Wide Area Augmentation System (WAAS).

In addition to display considerations, some thought should be given to the accuracy of the GPS receiver used for operator steered systems. An operator probably cannot make steering corrections that result in pass-to-pass accuracy less than 6-8 inches over an extended time period. Therefore, purchasing a GPS receiver that is more accurate than this is probably 'overkill.' While a dual frequency receiver may be alright on an operator steered system, RTK should be reserved for auto steering systems.

Initially auto steer systems used highly accurate and precise RTK GPS systems. However, systems using less accurate GPS receivers have been introduced in the last few years. The pass-to-pass precision of these less accurate systems is adequate for many field operations, but they may not be able to return to the same exact spot at some point in the future.

The key item to consider when selecting an automatic steer system is accuracy of the GPS system. For example, RTK guidance may be more than you need for typical field tillage or maybe even spraying. However, the RTK system may be exactly what you need for planting row crops or strip tillage. Other features to consider are ease of use and the operator interface. The best thing to do is take a test drive before you purchase a system.

Photo courtesy of Dr. Matt Darr, Iowa State University

This photo shows the repeatability of three differential correction sources. A paint canister was installed on the hitch of a Deere 8230 tractor and used to mark the true path of travel of the tractor on an AB line. The RTK path is marked with red paint, while yellow paint was used for SF2 (dual frequency), and blue paint for SF1 (single frequency). A new paint line was made every two hours over a six hour period. The lines easily show the GPS drift associated with different correction sources.

Upcoming Events

- ***Ag Technology/No-Till Field Day***
  July 27, 2010
  Northwest Technology Center
  Fairview, OK
- ***Kansas Ag Technology Field Day***
  August 10, 2010
  Airport and Exhibition Grounds
  Great Bend, KS
  www.ksagresearch.com

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