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Improvements and innovations in vented pile storage methodology and construction.

ABSTRACT

The process of ventilating outside stored sugar beet piles has seen many years of improvements and refinements and been worked on by many individuals. The basic approach is sound and productive. The labor intensiveness and cost of materials to achieve the proper results have always been key factors in deciding its usage as a storage approach. The development of new methodologies and the use of new materials and instrumentation have made the assembly, the operating and monitoring of ventilated storage more feasible.

The Amalgamated Sugar Company has utilized outside vented and covered pile storage in their South Central Idaho area of operations for some years now. Many improvements and adjustments have been made over this period of time to improve, decrease cost, and better manage the systems used. Currently we put approximately 350,000 tons under this type of storage, divided between five locations around the Magic Valley. The usual pile configuration is 700 to 900 foot of pile with widths ranging from 150 to 225 feet and piled 25 feet high.

The methodology used in constructing the ventilation system consists of placing a system of rows of steel culvert pipe which are 38 inches in diameter, underneath the beets as they are piled upon delivery. These rows of pipe are spaced 12 feet on center. Each row of pipe extends from the outside edge of the pile into the interior of the pile but does not join in the middle. There is a 10 to 15 foot gap in the middle where the rows do not join. We use this gap to access beets with a skip loader which are scooped up and placed on the aft side of the pipes to keep them from rolling out of place when the piling boom fills in behind and over them. Each side of pipe is independent of the other for purposes of running fans independently relevant to temperature needs. A piece of vinyl tarping material is banded over the inside ends of the last pipe to the middle and three or four, 3-4 inch holes cut in it. The pipe used is 12 gage, spiral corrugated, galvanized culvert pipe. They have two rows of 2 inch diameter holes spaced every 8 inches the length of the pipe, positioned at 8 and 4 o'clock. These holes are to allow the air blown into the pipes to be uniformly dispersed into the pile. We use a combination of 23 foot and 11.5 foot pipes. The first 23 foot pipe in the row which extends at least 4 feet beyond the edge of the retaining straw bales does not have any holes on the outward 10 feet of pipe. The remaining length of this first pipe has some holes cut in it but only half as many as the other pipes used on the interior of the pile. This obviously relates to slope of pile sides, (less volume of beets), and the dispersing of air the whole length of the pipe run. The next pipe section in from the outside is 23 foot in length and the rest are 11.5 foot lengths.

We place large straw bales, (4'x4'x8'), between the pipe at the outside edge of the pile, leaving at least 4 feet of pipe extending beyond them. This allows for connecting of air plenum bladders, as well as leaving room to work behind the bladders, and also leaves room for snow which tends to slough off the side of the pile. Before placing a pipe between bales, a scoop of beets is dumped between the bales, and then the pipe is placed over them. This elevates the end of pipe, allowing for the placing of a sleeve from the air delivery plenum bladder over the pipe end. The straw bales also serve as a retaining wall for the edge of the beet pile; as insulation for the toe of the pile, and as a means to anchor the edges of the pile covering tarp which will be constructed over the pile of beets.

Alignment of pipe rows and ends of pipe, straw bales etc. is important if the rest of the equipment is to fit together properly. This also facilitates the reloading process at the end of the storage. Angled rows and misplaced pipe tends to receive more damage by the loaders because they can only guess as to where they are.

To deliver air to the pipes, a plenum is constructed of vinyl tarping material. Our first attempt at delivering air from one fan to four pipes was a plenum box constructed of a ¾ inch angle iron frame covered with a vinyl tarp. These plenums were very time consuming to construct and tended to get frozen to the ground when water seeped into them and self destructed as you tried to free them. They delivered air from a 48 inch, cast aluminum fan, which rated at 15 hp and delivered 20 to 22 cubic feet of air per ton per minute. In 2000 we expanded our vented pile numbers from 2 to 5, at which time we had some heavy, vinyl, six pipe, plenum bladders built for delivering air from 25 hp, fiberglass bladed fans which also deliver 22 cu. ft./ ton/ minute. These bladders are durable but quite heavy and require cabling up to aid their inflation; to lesson flexing of the material which causes ware cracks, and to hopefully help when heavy snow fall occurs. Some shoveling is needed anyway at times to help them inflate after a heavy snow storm.

Because of the labor and complications of working with the rigid framed plenums which we originally tried, and also because of the expense to purchase and maintain the heavier, pre-constructed plenums, as well as inflation problems, we came up with a lighter, less expensive construct of air bladder plenum. Made of 8 oz. Poly-ethylene coated tarping with 15 oz. truck tarp vinyl sleeves sewn into the main plenum tube, they are light enough to self inflate even when it snows and inexpensive enough to discard after 1-2 years of service life. We construct these bladders ourselves with a hand held sewing machine prior to harvest and only construct as many as are needed for replacement each year.

The sleeves of these vinyl plenum bladders are attached to the vent pipes with ¾ inch steel banding. The sleeve is slipped over the end of the pipe about a foot and then the banding is secured around it and tightened to the pipe. The sleeves which connect to the fans are secured with 3/8 inch plywood lathes and screws, securing the sleeve opening to a 2x6 wood frame already secured to the fans metal box frame.

Portable power breaker boxes, and starter switching equipment is moved into place at two of our storage sites and the fans are plugged in and readied for operation. At three of our storage sites the power supply, switching equipment, and controls have been housed in a centralized building of cement block construction. The plug-ins for the fan motor cords are spaced down the sides of the piling ground area and mounted on posts. The fans here are simply moved into place and plugged in and readied for operation.

The placement of the fan opening in the plenum bladder is in the middle of the bladder, opposite the pipe sleeve openings. This started out as a standard pattern. At one of our sites we had some complaint about the noise which the operation of the fans projected out into the community. This season at the suggestion of the site manager who is the fieldman, we connected the fans to one end of the plenum bladder and angled it toward the pile. This has seemed to work well to address the noise issue. The noise is projected into the beet pile and the noise is dampened.

To facilitate the operation of the fans so that they run at the proper times when cooling ambient air is available, we insert thermal-couples into the tops of the beet piles which are then hard wired into a computerized switching system. The thermal-couples are inserted into a length of ¾ inch electrical conduit which has been flattened on the end which is to be inserted into the pile. The top end has a sending unit in a cast metal head clamped to the conduit tube. The wire is a two pair, foil shielded electrical cable, which is run to a juncture box at our sites where we have equipment buildings and then a 16 pair lead cable is run down the side of the pile to the control room. At our sites where portable control panels are used, the lead from the thermal-couple is ran directly down the side of the pile to the control box. The thermal-couples serve to operate two or three fans on the same side of the pile, depending on the arrangement of the site system. You want to have them regulate the fans on the same side of the pile for the obvious reason that temperature conditions one side of the pile verses the other can be different.

The temperature signal, send from the thermal-couple is received into a CPU (computer programmable utility), which compares the given pile temperature to the ambient air and turns fans on if ambient air is cooler, and within the parameters in which the system is set to operate. The pile temperatures, run time or duration of fan operation, wind speed, and ambient air temperature are displayed on a computer screen. The system is also linkable to the field-mans home or office computer via Symantec PC Anywhere, (a remote operating software system). This is accomplished over the internet and you only need the phone number and the access code. This allows one to call up the system at any time and access the information about the status of the storage pile. This saves many miles of travel and allows for more frequent monitoring of the pile and conditions on site.

At the two storage sites where we do not have housed switching equipment, but portable panels, we have utilized a very adaptive, small CPU manufactured by Siemens, called a LOGO. It can perform the same functions of reading the pile temperature, comparing it to the ambient working air temperature, turning fans off and on when appropriate, as well as logging run time. They can also be programmed to turn fans off or on at preset times. This we do when sustained cold, below freezing temperatures, occur. At these times we set the fans to run at the warmest time of the day which is usually mid-afternoon, and we do this to freshen the pile or vent the warm air build up out for 1 but not more than 2 hours, and then the fans shut off.

About the 25 th of October, and before we are finished receiving all the beets into the piles, we start the tarping or covering of the vented beet piles. We have found that waiting until later risks exposing the outside crust of the pile to severe freezing. When this happens, the top layer of beets, one to two beets deep, sustains enough damage that they do not store well and are quite deteriorated before re-load time comes in February. We start on the beginning ends of the vented beet piles and tarp as much as we can on each pile and then move to the next. By the time we have rotated to each pile, we can usually go back and finish the first and then the next etc. for completion.

The tarping is constructed of 8 oz. pvc woven fiber material, coated with a polyethylene coating. We have found this material able to withstand the flex and riggers of pile cover. We tried pvc coated material but the coating cracked and frayed more readily. Three tarps are used to cover a section of 108 linear feet of pile. The tarping material is manufactured in 12 foot wide rolls. Our supplier then heat seams nine sections together to give us the 108 foot dimension. The other dimension of size is determined by whatever the up-and-over the pile, side to side, measurement is, divided by three. The first tarp piece is placed on top of the pile and unfolded. Then a side piece is laid out next to it and the two are sewn together with a hand held sewing machine. We use Union Special 2000 sewing machines which sew a double locking stitch. We use a small portable generator to power the machines. The next side piece is laid out and stitched to the other side of the top piece and then both sides are pulled over the top edge of the pile and down the sides. Another top piece is next laid out and then the side pieces which are stitched to the sides of this top or middle piece. Then the two completed sections of tarp are sewn together from one side of the pile, up and over to the other side. The tarping is then pulled to stretch any wrinkles or slack out of them. This pattern continues until the pile is covered. Originally, just two larger tarps were used but the weight and bulk was very hard to handle. An average pile which we cover takes 7 sections of 108 foot length to cover, plus the end pieces. The ends are covered using used tarps from previous years which are still in fair shape. The reason for this is that the ends take quite a beating from weather over the storage period and after such use the tarps are usually discarded.

We have tried different hole configurations for allowing the vented air to move out of the pile. The flapped vent was originally used, with the idea in mind that when the fans were not running the flaps would lay back down and protect the opening as well as shed moisture. There were problems with ice and snow accumulation around these openings however. When we tried to remove them, if conditions were not right we would have to chisel and pound the ice from around them. The tarps readily tore at these types of openings also. We have landed on the pattern of 3 inch diameter holes spaced one in every 21/2 square feet of tarp area. This works quite well. It allows air to vent out of the pile and still provides some measure of protection from deep frost penetration. The round hole shape is also harder to start a tare from.

Two inch seat belt webbing is used to secure the tarps on the pile and keep them from billowing and blowing away. We have learned to conveniently store them and handle them on cable reels. We attach the webbed strapping on one side of the pile to a vent pipe, up and over the top to the vent pipe on the other side, using the vent pipes sticking out of the pile as a place to attach and secure them. A come-a-long tightener is used to attach the strapping as tightly as possible. Wealso attach the bottom edge of the tarps to the straw bales between the vent pipes using rough 1x4x6 foot lengths of lumber with holes drilled in them. The tarp edge is folded back under itself with the board in the fold. Then three metal stakes made from 3/8 inch re-bar, 30 inches long with a ring formed on one end and welded are pushed through the tarp, the holes in the board, and the tarp and into the straw bales.

In addition to securing the tarps with two inch seat belt webbing, we tried this year for the first time, running two lengths of 3/8 inch steel cable from one end of the pile to the other. Each was spaced equally on the top of the pile. At each juncture where the cable passed over a strap, we secured the juncture with a zip tie. This helps by creating a netting of the two over the tarp. It also keeps the straps from working sideways when the wind blows which in turn was allowing more billowing of the tarp which can result in damage to it.

Also, because of the wind, (which never blows in Idaho), we have found it very necessary at one of our storage sites to further secure the top of the pile, i.e. the tarps, with large straw bales. This is done by lifting them on top of the pile with a service crane and then rolling them in place all over the top of the pile tarp. We also have a wind meter, (an anemometer), at three of our sites which is wired into the operating system and programmed to shut the fans off if they are running when the wind speed gets above 15 mph. This saves tarps. When the fans are operating, the tarp is lifted off the beets just enough that when the wind blows it tends to start rippling, which when severe enough can fray and tare and destroy the tarps.

Even with the protection of tarping we can still get frost penetration to some degree into the sides of the piles. The north side and the west sides are mainly affected with both sides affected when we get sustained, severe cold periods like this past December and January. We take the tarps off in mid February in preparation for re-loading. This year we are finding it affective to load the frosted sides out for processing before or as they begin to thaw and are still capable of being processed. This is being done with a track hoe that has a long reach which can work over the top of our air delivery equipment leaving it in place. We continue to ventilate the piles until each section must be removed for reloading and processing.

Results: We have found this storage approach to be useable and cost affective to the degree that in good storage years juice purities can increase 1 to 2 percent when we move from non-ventilated, uncovered piles into the ventilated, covered piles. In poorer storage years the increase can be even greater, 3-4 percent. This amount of increased extraction when applied to 300,000 – 350,000 tons of beets represents significant savings.