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FOOD TECHNOLOGY FACT SHEET

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Low-Cost Pecan Sanitizer Plans for Small-Scale Producers

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Introduction

The word “pecan” comes from the Algonquian Native American language. It references any nut that requires a stone to crack. Found originally in parts of central and eastern North America and the river valleys of Mexico, the pecan was favored by indigenous, pre-colonial people because of its flavor and easy accessibility. Simply stated, it was an easy nut to crack (National Pecan Shellers Assn., 2017). Today, U.S. pecan production tops an estimated \$500 million a year with roughly one third of that exported to other countries (USDA, 2017).

To be salable under the USDA’s U.S. No. 1 classification, pecans must be free from “loose extraneous or foreign material” (7 CFR § 51.1400, 2017). The low water activity of pecans and the fact that they are housed in a shell generally protects against the presence of pathogens. However, because the nuts often are harvested from the ground in areas inhabited by livestock and wildlife, the potential for surface contamination of the shell exists.



Courtesy of Valley View Pecan Co., Shawnee, Oklahoma

To protect the kernel inside the shell, it is necessary to sanitize the shell prior to cracking. Sanitizing reduces the risk that pathogens are present on the shell surface and follows Oklahoma State Department of Health guidelines (2017) under OAC 310:260. In section 5-1 (b), the regulation states that all pecans “shall be subjected to a bactericidal process” by either:

- Immersion in hot water at 170 degrees F or greater for at least two minutes, or a flow of hot water at 170 degrees F for at least 5 minutes, or be exposed to 180 degrees F hot air for at least 20 minutes.
- A 1000 ppm chlorine equivalent (surface sanitization of the shell) and a floatation process of 200 ppm chlorine equivalent (sanitization of the kernels if all shells are removed. This step is not required if pecans are only cracked or cracked with partial shell removal such as “cracked and blown”).
- Exposure to steam for at least 15 minutes at 170 degrees F or exposure for 5 minutes at 200 degrees F.
- Exposure of a jet of live steam for at least 1 minute.
- Any other bactericidal treatment which has been proven by laboratory test to effectively sanitize pecans and which has been approved by the Oklahoma State Department of Health.

Many small producers do not have access to commercial sanitizers or live steam for sanitation. A practical answer for small producers is exposing in-shell pecans to a 1,000 ppm chlorine solution. This sanitizing process can be placed in between the sorting conveyor (pecan cleaner) and the lift conveyor for packing. A drawing of the proposed pecan sanitizer is shown in Figure 1.

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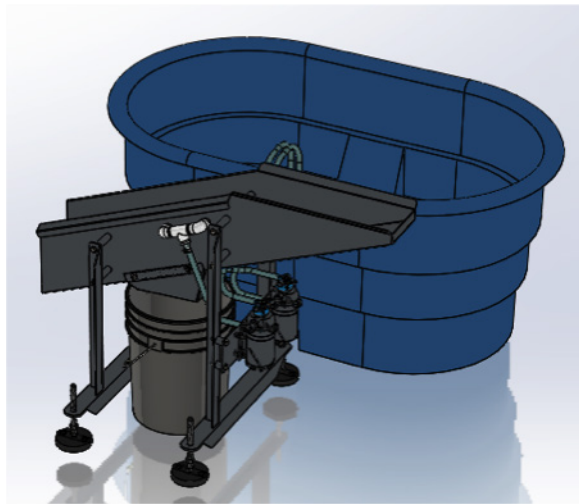


Figure 1. Low Cost Pecan Sanitizer

Design Concept

When approaching the design for a pecan sanitizing process, three important aspects were considered. First, it had to effectively sanitize pecans. Second, the design needed to be relatively flexible. While it is unlikely any design can be considered a one-size-fits-all solution, it is important for the design to fit as many situations as possible. Finally, it needed to be affordable. To accomplish this goal, moving parts, machining labor and welding were minimized. Construction materials were made from generally accepted common stock. Purchased parts were available over-the-counter at most hardware stores. It is estimated the unit cost (not including labor) should be between \$1,000 and \$1,500.

The concept for the pecan sanitizer utilizes a difference in height between the debris removal conveyor and the incline conveyor used to load the sanitized pecans into intermediate packaging (totes, super sacks, etc.) (see Figure 2). Gravity moves the product through the sanitizer's channel, angled at 22.5 degrees, and underneath a dual waterfall of 1,000 ppm chlorine solution. Once the pecans are exposed to the chlorinated water, they drop onto the incline conveyor where air blowers can be used to remove excess water and dry the nuts.

Water not absorbed by or adhering to the pecans falls through an expanded or perforated metal sheet and is funneled into a reclaim bucket. This water is then pumped back into the main chlorinated water tub to be reused.

Low velocity pumps (3gpm @ 20psi) are used to move water to the waterfall and then to return it from the reclaim bucket. The low-velocity approach to moving

the chlorinated water reduces vaporization of chlorine into the air.

Methods and Materials of Construction

Figure 3 gives a 3-D view of the completed sanitizer. High resolution, detailed layout and assembly drawings are available in the digital drawing package that may be downloaded by visiting <http://fapc.biz/services-and-disciplines/pecan-sanitizer-plans>. The drawing titles will be referenced in all capital letters in the following sections, e.g. ASSY, WATERFALL ½" PVC.

The machine components are made of SAE 304 grade, or better, stainless steel. This is due to the fact that, first, it is a food-processing device and, second, stainless steel is more resistant to the corrosivity of chlorine than mild steel. The product pathway (CHANNEL, PECAN MAIN) is made of standard 14 gauge sheet metal. This part should be cut on a Computer Numerical Control (CNC) cutting device such as a water or laser cutting machine, or plasma cutter.

The Main Channel is then broken from a flat pattern per the instructions in the CHANNEL, PECAN MAIN drawing.

The plastic tubing used to pump chlorinated water to the waterfall assembly (ASSY, WATERFALL .50 PVC) should be FDA approved for food use. The tubing should also be clear or translucent so that obstructions and unsanitary buildup can be easily identified.

The waterfall assembly was designed using standard schedule 40 PVC pipe fittings. This could be easily substituted with schedule 40 stainless steel pipe and fittings. Stainless steel will handle the wear and tear of a farm application better, but PVC will cost less and is more resistant to chlorine corrosion.

The hole pattern in the waterfall assembly was designed to be offset from center so that when plumbed in this manner, the two pipes provide 100 percent coverage in the direction tangential to the channel pathway. To do this, the two reworked nipples (RWK, 50 NPT and PVC NIPPLE x 8 LG) will need to be installed in an offset orientation from the base 90 degree fittings.

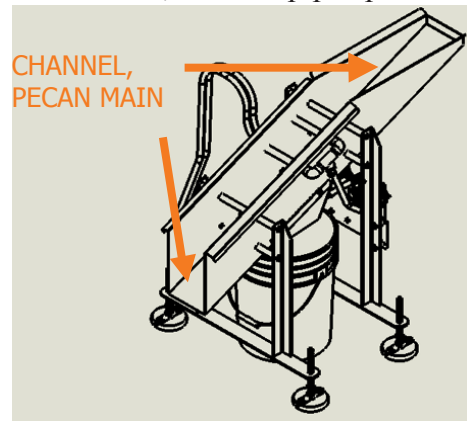
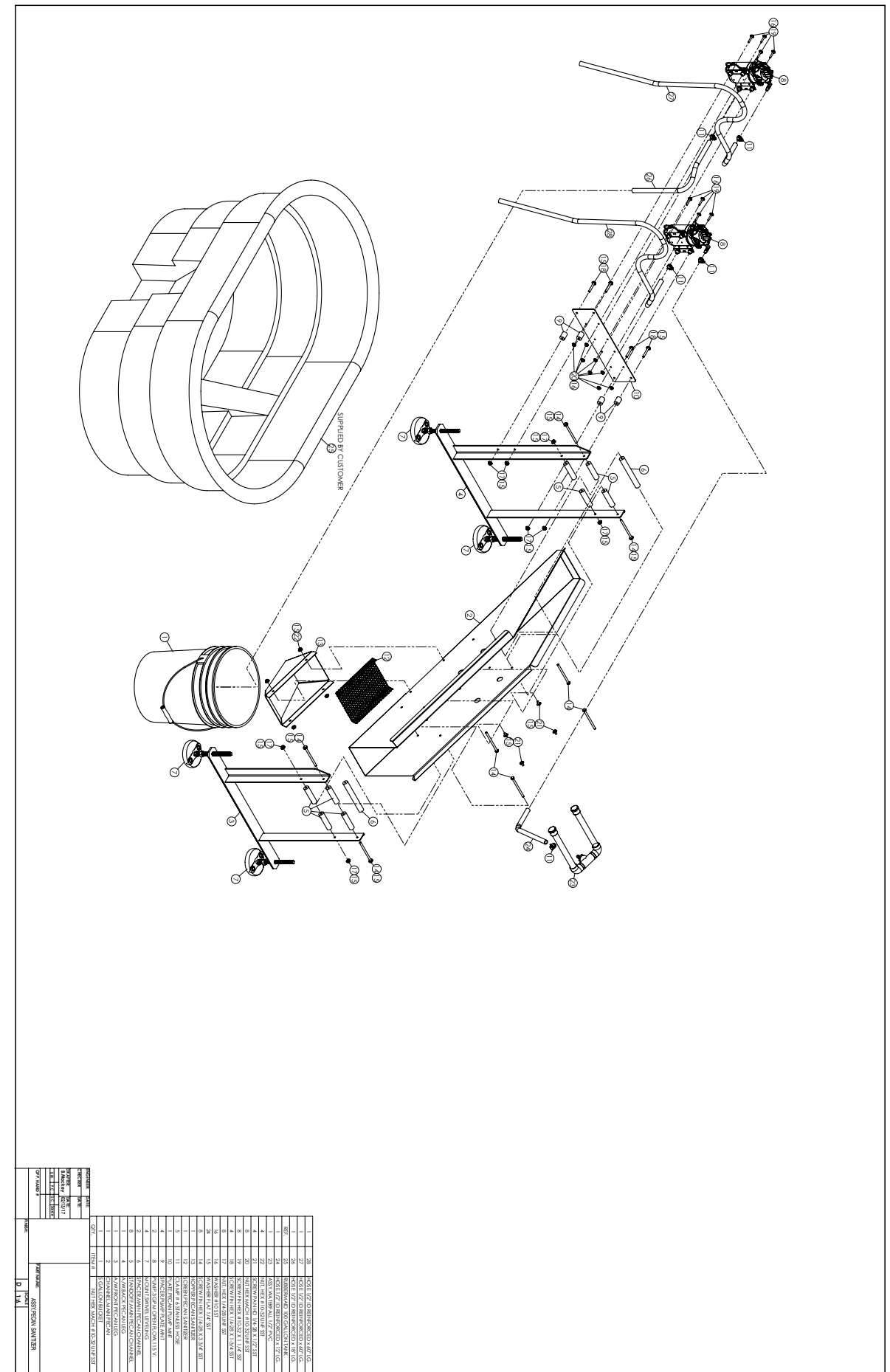


Figure 3. Three dimensional view of sanitizer

ASSY, PECAN SANITIZER ISO



ASSY, PECAN SANITIZER

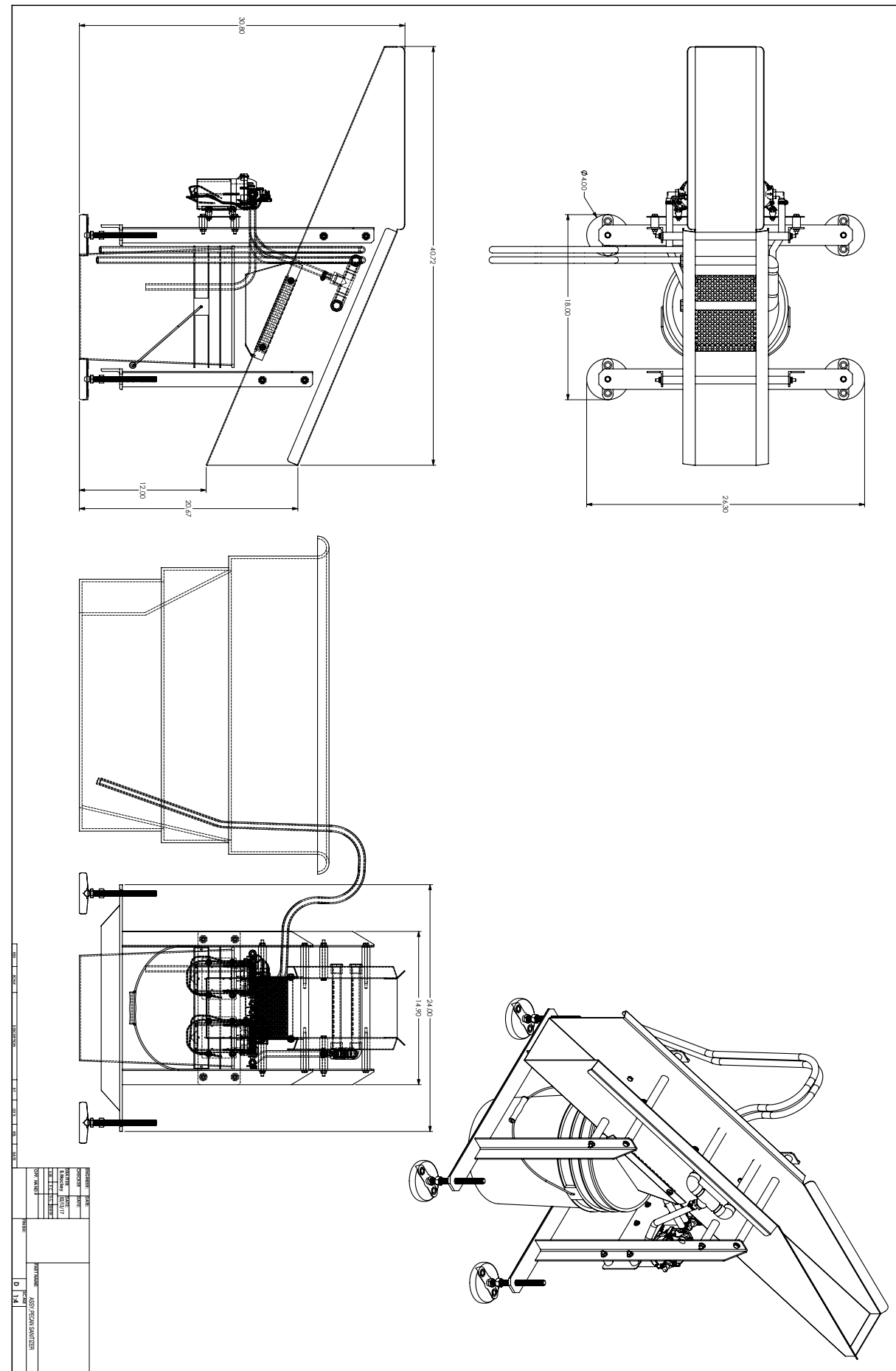


Figure 4 shows the interlaced hole patterns that provide the coverage and the directional assembly of each pipe.

The legs are a weldment. They use stainless steel angle iron uprights welded to a stainless steel angle base. The angle was extended to widen the base of the unit to provide more stability. The drawings call for tungsten inert gas (TIG) welding using typical fillet welds. This, however, can be accomplished using any welding technique. Welding filler rod or electrodes should be 308L or better. Welds should not be cleaned with a wire brush but rather with a stainless wire wheel or buffing pad. This will help prevent the welds from rusting.

The design calls for two SHURflo® positive displacement, 3-chamber diaphragm pumps rated for 3 gallons per minute at 20 pounds per square inch (PumpAgents.com, 1998). These pumps are directional.

Directional means they have a specified inlet and outlet. For this design, the inlet of Pump 1 should pull from the 100-gallon tub and the outlet should feed the waterfall assembly. The inlet of Pump 2 should pull from the reclaim bucket and the outlet should feed the 100-gallon tub.

SHURflo® pumps are readily available and reasonably priced at roughly \$150 per unit. This pump can be substituted with a wide variety of pumps. It is important to ensure that the pump chosen is rated for chlorine water and displaces no more than 5 gallons per minute. It also is important to note the hole pattern for a substituted pump will more than likely vary from the pump called for in the drawing (PLATE, PECAN PUMP MNT) and will need to be modified (see Figure 5).

The main channel (Figure 6) was designed to provide 18 inches of fall between the two conveyors. There was 4 inches of adjustment in the feet (+/- 2"). The infeed height was roughly 30 inches and the discharge height roughly 12 inches. The overall height can be modified by extending or shortening the legs in the AW, BACK PECAN LEG AW, FRONT PECAN LEG weldments. All four legs will have to be modified by the same amount for the machine to sit level.

To change the fall of the machine from the current difference of 18 inches requires some forethought as it means a change in the CHANNEL, MAIN PECAN flat pattern prior to bending.

The channel runs at a 22.5-degree angle and is the hypotenuse of a triangle (Figure 7). Pythagorean's theorem must be applied to find the net elevational rise. The legs will most likely need to be extended to meet

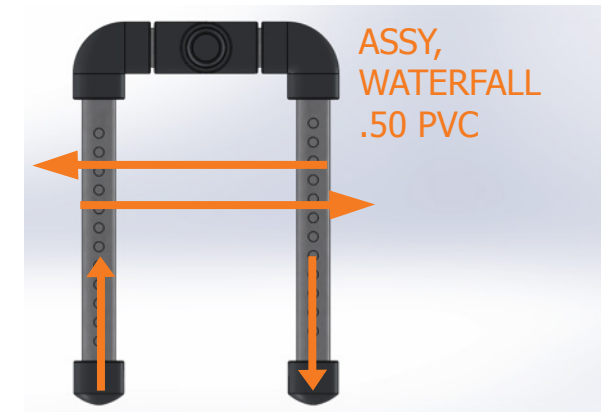


Figure 4. Layout of the waterfall assembly

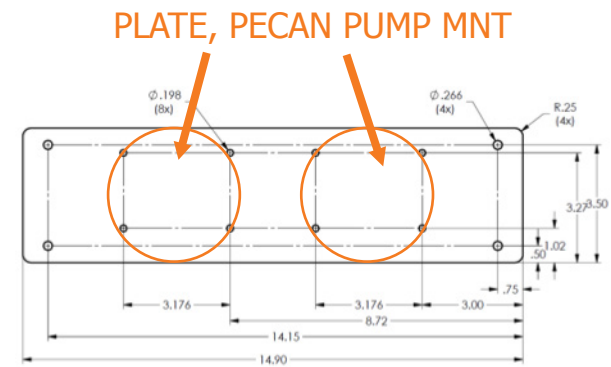


Figure 5. Pump mounting plate

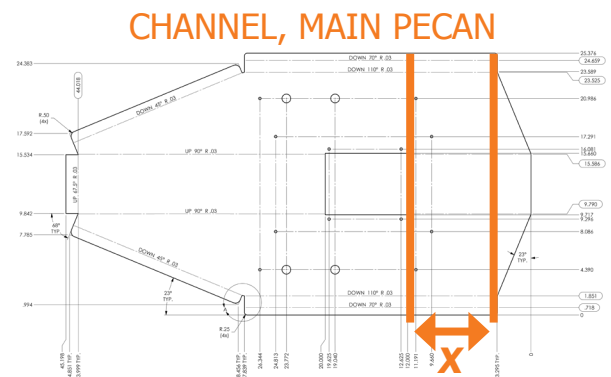


Figure 6. Main Pecan Channel Sheetmetal Layout

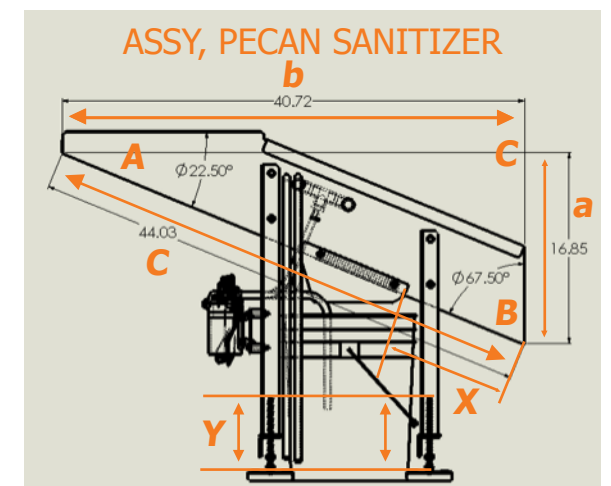


Figure 7. Pecan Sanitizer Assy dim Sheet

the lower and upper elevational height requirements. This can be done by extending the leg dimensions by the same amount of rise applied to the CHANNEL, MAIN PECAN.

To change the fall (currently 18 inches), modify the net length of dimension 'a' by changing the length of dimension 'c' in the CHANNEL, MAIN PECAN (as previously stated). To determine the change required in 'c', we can use the Law of Sines:

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

Since the angles never change, the trigonometry can be calculated as:

$$\sin A = 0.38268 \quad \sin B = 0.92388 \quad \sin C = 1$$

In this case, we declare the dimension of 'a' to be the desired fall height and we calculate to find the new length of 'c':

$$(\text{New 'a' declared})/0.38268 = \text{length 'c'}$$

Table 1 gives a range of possible dimensions for the main pecan channel. When changing the fall of the machine it is also important to increase the length of the legs to account for the lengthening of dimension 'c.' This can be done with the following equation:

$$y = \text{New 'a' - 16.85}$$

Assembling the Pecan Sanitizer

There are a few considerations for assembling the sanitizer. Start by installing the hardware into the CHANNEL, MAIN PECAN. In particular, install the SPACER, MAIN PECAN CHANNEL first to ensure the hardware aligns with the holes. Often when bending sheet metal where the holes are first cut in the flat, minor alignment issues can occur. This can be overcome by installing the spacers before the assembly is completely rigid.

Second, install the SCREEN, PECAN SANITIZER and the HOPPER, PECAN SANITIZER. These two parts use common hardware and should be installed together. After this, install the PLATE, PECAN PUMP MNT to the A/W, BACK PECAN LEG. Next, move on to the two leg weldments, A/W, FRONT PECAN LEG and A/W, BACK PECAN LEG, and install them to the CHANNEL, MAIN PECAN.

When building the ASSY, WATERFALL 1/2" PVC (Figure 8), it is important not to install the two FITTING, 1/2" PVC Caps until the assembly is installed in place in the CHANNEL, MAIN PECAN. Installing the caps on the waterfall assembly before placing it through the holes of the CHANNEL, MAIN PECAN will result in an interference.

Finally, install the pumps (PUMP, 3 GPM OPEN FLOW, 115 V) to the PLATE, PECAN PUMP MNT and affix the hoses to the pumps. The pumps should come with a cord and plug. The two pumps can be wired in parallel so that only one plug is required. A switch can be added in series to the pumps. The design provided does not address any electrical controls and assumes that both pumps will simply be plugged into an 115V 60 Hz outlet. A licensed electrician can help with these and any additional controls required to meet the application.

The pumps are enclosed and there are no moving parts on the apparatus. Therefore, no special guarding is required under 29 CFR 1910.168.

Conclusion

The pecan sanitizer design is provided without any intellectual property infringement or liability of performance.

The Pecan Sanitizer, when properly operated, meets federal and Oklahoma guidelines for a bactericidal process. It is important that any product that passes through the apparatus is fully coated by the 1,000 ppm chlorinated water solution. Biological matter and exposure to air will weaken the strength of the chlorine solution.

It will be necessary to periodically test and document the level of active chlorine present in the solution. Fact sheet FAPC-116 "Guidelines for the Use of Chlorine Bleach as a Sanitizer in Food Processing Operations" addresses this issue.

This fact sheet includes the layout drawing and the assembly drawing for the apparatus. The SolidWorks 2016 3D model and drawings are available by visiting <http://fapc.biz/services-and-disciplines/pecan-sanitizer-plans>. Questions or comments regarding this fact sheet may be sent to: fapc@okstate.edu.

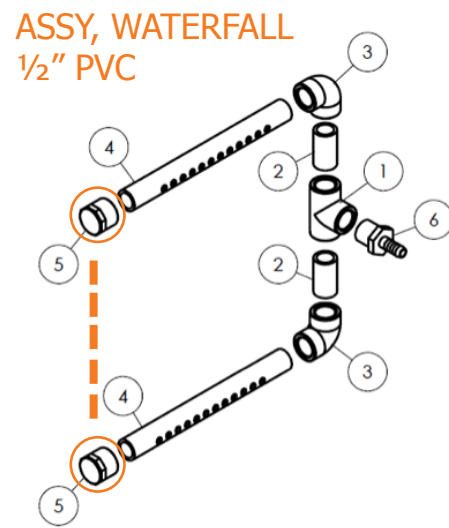


Figure 8. Pecan Sanitizer Waterfall Assy

Table 1. Fall Height Dimension Table

Desired Fall	Dim 'a'	Dim 'b'	Dim 'c'	Change in 'x'	Change in 'y'
13	13	31.39	33.97	(10.02)	(3.85)
13.5	13.5	32.59	35.28	(8.71)	(3.35)
14	14	33.80	36.58	(7.41)	(2.85)
14.5	14.5	35.01	37.89	(6.10)	(2.35)
15	15	36.21	39.20	(4.79)	(1.85)
15.5	15.5	37.42	40.50	(3.49)	(1.35)
16	16	38.63	41.81	(2.18)	(0.85)
16.5	16.5	39.83	43.12	(0.87)	(0.35)
17	17	41.04	44.42	0.43	0.15
17.5	17.5	42.25	45.73	1.74	0.65
18	18	43.46	47.04	3.05	1.15
18.5	18.5	44.66	48.34	4.35	1.65
19	19	45.87	49.65	5.66	2.15
19.5	19.5	47.08	50.96	6.97	2.65
20	20	48.28	52.26	8.27	3.15
20.5	20.5	49.49	53.57	9.58	3.65
21	21	50.70	54.88	10.89	4.15
21.5	21.5	51.91	56.18	12.19	4.65
22	22	53.11	57.49	13.50	5.15
22.5	22.5	54.32	58.80	14.81	5.65
23	23	55.53	60.10	16.11	6.15
23.5	23.5	56.73	61.41	17.42	6.65
24	24	57.94	62.72	18.73	7.15
24.5	24.5	59.15	64.02	20.03	7.65
25	25	60.36	65.33	21.34	8.15
25.5	25.5	61.56	66.64	22.65	8.65
26	26	62.77	67.94	23.95	9.15
26.5	26.5	63.98	69.25	25.26	9.65
27	27	65.18	70.56	26.57	10.15
27.5	27.5	66.39	71.86	27.87	10.65
28	28	67.60	73.17	29.18	11.15
28.5	28.5	68.81	74.47	30.48	11.65
29	29	70.01	75.78	31.79	12.15
29.5	29.5	71.22	77.09	33.10	12.65
30	30	72.43	78.39	34.40	13.15

Table 1. Dimensions for all three lengths of the main pecan channel and the change in 'x' and 'y' elevations required to obtain them.