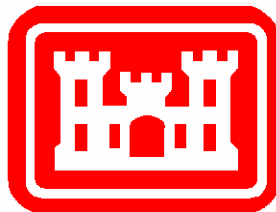


PUBLIC WORKS TECHNICAL BULLETIN 200-1-59
1 JULY 2008

**PILOT STUDY USING WOOD CHIPS AS AN
ABSORBENT TO TREAT WASTEWATER FROM
GREASE TRAP SERVICING**



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Facilities Engineering
Environmental

PILOT STUDY USING WOOD CHIPS AS AN
ABSORBENT TO TREAT WASTEWATER FROM GREASE
TRAP SERVICING

1. Purpose.

a. The purpose of this Public Works Technical Bulletin (PWTB) is to make available the results of a pilot study that investigated one method to treat wastewater generated by servicing dining facility grease traps at Army installations.

b. All PWTBs are available electronically (in Adobe® Acrobat® portable document format [PDF]) through the World Wide Web (WWW) at the National Institute of Building Sciences' Whole Building Design Guide web page, which is accessible through URL:

http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215

2. Applicability. This PWTB applies to all U.S. Army Directorate of Public Works (DPW) activities responsible for the maintenance of grease traps that serve as pretreatment devices for dining facilities.

3. References.

a. Army Regulation 200-1, "Environmental Protection and Enhancement," 13 December 2007.

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b. Title 40, Code of Federal Regulations, Part 403 (40 CFR 403), "General Pretreatment Regulations for Existing and New Sources of Pollution."

c. 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities."

d. 40 CFR 264.314, "Special Requirements for Bulk and Containerized Liquids," 1 July 2005.

e. 40 CFR 264.314, Method 9095A, "Paint Filter Liquids Test," September 1986.

4. Discussion.

a. AR 200-1 requires that Army installations comply with pretreatment standards established by authority of the Clean Water Act.

b. 40 CFR 403 describes general and specific limitations on the discharge of wastewater from industrial users to publicly owned treatment works. As stated in paragraph a. above, this also applies to industrial discharges to Federally Owned Treatment Works. According to the general limitations defined in the CFR, no industrial user can introduce into a treatment works any pollutant that will cause interference. The CFR specifically states that oil and grease in amounts that will adversely affect a treatment works are prohibited from entering a treatment works.

c. 40 CFR 264.314 prohibits landfilling wastes that contain free liquid.

d. Most Army installation Directorates of Public Works depend on contractors to service dining facility grease traps and then dispose of the waste removed from those traps. Because of rising costs, Fort Hood wished to determine the feasibility of a more proactive approach to grease trap waste disposal. It was believed that disposing of the wastes in-house would both ensure that the wastes were disposed of properly and decrease rising disposal costs. An investigation was accomplished through the former Waste Minimization and Pollution Prevention Program (often referred to as WETO) which was administered by U.S. Army Engineer Research and Development Center's Construction Engineering Research Laboratory. All work for that program was performed by MSE Technology Applications, Inc. (referred to as MSE throughout this PWTB), a non-profit engineering firm in Butte, Montana.

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e. Fort Hood generates about 700,000 gallons of grease trap waste annually from several dining facilities on post. This waste contains significant amounts of free liquid, which prevent it from being disposed of at the Fort Hood landfill. If the majority of the grease could be solidified and separated from the water, the solidified grease could then be disposed in the Fort Hood landfill. MSE initially investigated four alternative treatment scenarios for solidifying the grease to determine which was most appropriate for Fort Hood. Researchers selected a two-stage filter system that used wood chips as the primary media and a commercial adsorbent as the secondary media. The system was then pilot tested. While the secondary filter failed to operate as expected during the pilot study, it was concluded that wood chips had significant potential as an adsorbent for treating water containing large concentrations of grease. Fort Hood hopes to receive funding to perform a larger scale demonstration/validation of using wood chips as an absorbent.

f. Appendix A contains a detailed description of the study performed at Fort Hood by MSE.

5. Points of Contact (POCs). Headquarters, U.S. Army Corps of Engineers (HQUSACE) is the proponent for this document. The POC at HQUSACE is Malcolm E. McLeod, CEMP-II, 202-761-0632, or e-mail: Malcolm.E.Mcleod@hq02.usace.army.mil.

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Appendix A: Fort Hood Grease Trap Waste Solidification Study

Background

Food preparation and dish washing areas of Army dining facilities generate wastewater that has a high concentration of liquefied grease. This wastewater must be managed properly to comply with environmental regulations. If this wastewater is dumped directly into a sanitary sewer, it could cause blockages in the wastewater collection system, and possibly cause wastewater to back up into the kitchen facility. While these blockages are primarily considered a maintenance problem, they are also a violation of the pretreatment requirements developed under the Clean Water Act (40 CFR 403). Thus grease traps are normally used to pretreat dining facility wastewater prior to discharge to a sanitary sewer. The grease trap is typically a simple device, often just a rectangular chamber where the hot greasy water is detained long enough to allow it to cool and slowed enough to prevent turbulence. As the wastewater cools, the grease and oil droplets coalesce and float to the top of the chamber. The water continues to flow to the sewer, while under-flow baffles retain the floating grease and oil in the top of the grease trap where it accumulates. The accumulated grease must be periodically removed to maintain the efficiency of the grease trap.

According to the solid waste management office at Fort Hood, the installation has 48 kitchen facilities throughout. The amount of grease trap waste produced annually at Fort Hood is approximately 700,000 gallons. Fort Hood grease traps vary in size, with the largest being 3,750 gallons, and the majority having a capacity of 1,500 gallons or less. A contractor services the grease traps once a week, emptying them using a vacuum truck.

The waste pumped from grease traps is a slurry of water, grease, and food particles. This slurry cannot be discharged to a sewer and, per 40 CFR 264.314, contains too much free water to be disposed of in a landfill. The serviced grease trap waste must be processed to remove free water so that it can be disposed of as a solid waste in a landfill. [Disposal by composting is discussed in another PWTB currently being prepared for publication.]

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Recent changes in grease trap decanting procedures as a result of Texas State regulatory requirements have increased the price of grease trap waste collection and disposal by 57%. These increases in handling and treatment costs have prompted Fort Hood to look for alternative methods for dealing with the waste. Fort Hood's Municipal Solid Waste Landfill Permit allows solidification of grease trap waste within the Class I landfill site, though the treatment is currently done off-post. If a solidification system were installed at the landfill, no additional permitting would be necessary, although approval from the Texas Commission on Environmental Quality would be required.

Treatment Alternatives

Several alternatives were considered for treating the Fort Hood grease trap waste. Methods used at other installations as well as recommendations from previous studies at Fort Hood were evaluated.

Fort Sill Operation

Some Army installations manage grease trap waste by removing the water from the slurry at designated areas where gravity separation and drying occur. For example, Fort Sill, Oklahoma, has built a system to drain water from grease trap waste sludge (Figures A-1 and A-2). The waste is first placed in a separation basin where much of the grease is removed. Liquid from that basin drains into one of several lined ponds, where the water evaporates. The solids are removed from the basin and ponds and are then placed in Fort Sill's nonhazardous solid waste landfill. Most of these drying ponds are shallow pools approximately 18 inches deep, 30 feet long, and 10 feet wide.

Previous Investigations

Previous investigations/studies of Fort Hood grease trap waste include the following:

- A characterization study conducted by American West Analytical Laboratories in December 2005.
- ECONOVA, Inc., conducted a bench-scale study involving screening and electro-coagulation.
- Environmental consultants with PLANTECO proposed a biological treatment of grease trap waste. The process involved using surfactants to disperse the grease, pH adjustment, and digestion by facultative anaerobic bacteria.

Process Selected for Pilot Study

MSE evaluated four treatment options:

1. gravity separation and drying (used at Fort Sill),
2. electro-coagulation (based on previous ECONOVA study),
3. biological treatment (based on PLANTECO proposal), and
4. a two-stage absorption process.



Figure A-1. Fort Sill waste receiving basin.



Figure A-2. Fort Sill drying pond.

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It was thought that the electro-coagulation process and the biological treatment process would be too expensive to operate, and the Fort Sill system would require too much space. Thus the absorption process (described below) was chosen for pilot-scale testing. This process was chosen because of the large quantity of readily available wood chips at Fort Hood and because the equipment needed for the system was inexpensive and non-specialized. The process was also considered most appropriate due to the characteristics of the waste stream (American West Analytical Laboratories analysis).

Absorption Process

The absorption process chosen consists of trickling the waste through a large cylindrical vessel filled with wood chips. The grease is removed from the liquid by absorption and filtration, becoming attached to the wood chip surfaces. The effluent from this process then passes through a secondary absorbent filtration tube.

Pilot Study

Conceptual Design

The pilot study was to demonstrate that the grease in grease trap waste could be solidified and separated from the water fraction of the waste stream using wood chips as the primary adsorption/filtration media. Effluent from this first stage of treatment was then passed through a secondary adsorption column. Both the expended wood chips and the secondary absorbent were expected to pass the paint filter test in compliance with 40 CFR 264.314, Method 9095A, and would be disposed at the Fort Hood landfill. The liquid effluent from the system would then be collected in a large holding tank for transport to further water treatment, sewer, or evaporation.

Most of the grease and suspended solids were expected to adhere and be absorbed in the wood chips. Placing the wood chips in a tall cylindrical tank allowed close contact with the grease waste. The waste water entered the top of the column creating a "trickle through" effect much like a stripping column might handle other types of wastewater.

The secondary absorbent column was to remove finer solids and possibly emulsified oil that passed through the wood chip vessel. The absorbent was fluidized and flowed counter-current to the water stream. Spent absorbent would exit from the upper end of the column while filtered water would exit the lower end of the column – ideally, free of grease, oil, and suspended solids. The products of the process are wood chips and absorbent material saturated with grease waste and other food solids.

Pilot System Sizing and Components

The pilot mechanical filtration process was designed to treat a 1400-gallon batch of grease trap waste (GTW) over a period of 6 days. The flow rate through the system was approximately 0.2 gallons per minute (gpm).

The primary system components included: a waste holding tank with recirculation capability and system feed pump, large absorbent vessel with mixing by auger, secondary absorbent column with counter flow movement of absorbent by auger (conveyer), and effluent water and spent absorbent storage. Figure A-3 shows a process diagram of the components.

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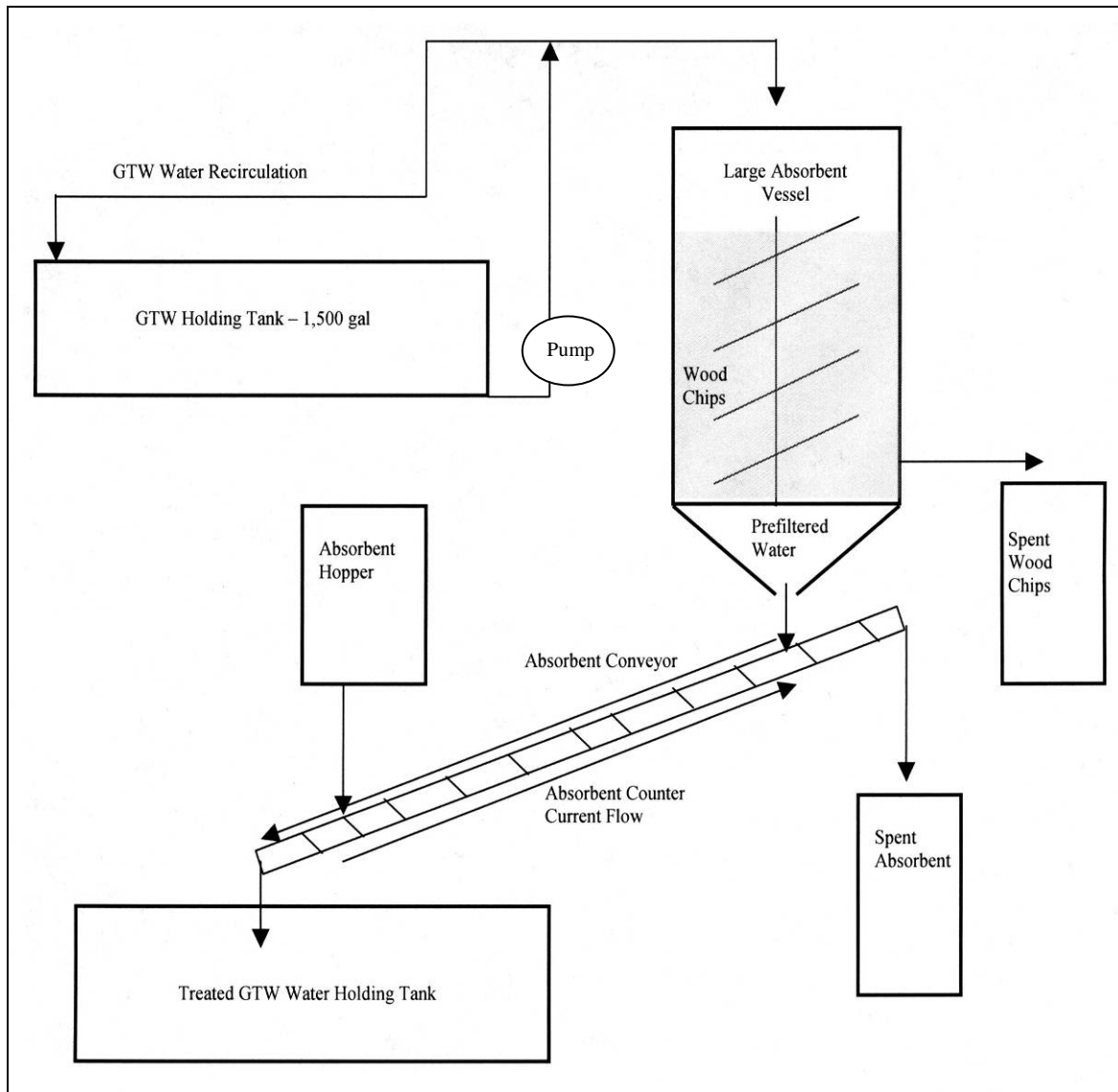


Figure A-3. System component flow diagram.

Grease Trap Waste Influent Delivery System

Fort Hood's environmental division provided used holding tanks to store the grease trap waste after delivery by the collection contractor, which helped defray some costs for the study. Two tanks were required to meet the storage capacity desired for a 6-day processing period. The larger tank's capacity was 1,000 gallons, and the second tank's capacity was 500 gallons. Figure A-4 shows the two tanks that were provided. Agitation of the waste was necessary to keep the grease in suspension and maintain a consistent feed throughout the 6-day test period. This was accomplished by recirculating the waste.

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Figure A-4. Waste influent holding tanks from Fort Hood.

The pump used to recirculate and to feed the waste to the treatment system was an off-the-shelf shallow well jet pump with a 1/2-horsepower (hp), 115-volt (V) motor intended for low flow irrigation from a 25-foot deep well. The pump provided approximately 8 gpm at a 12-foot lift. Figure A-5 shows the jet pump used for the exit stream out of the influent holding tanks.

The three main components of the shallow well jet pump were an electric motor, an impeller, and a jet assembly. Although a simple centrifugal pump would pump water at this lift, the jet pump greatly increased the discharge pressure and suction.

The jet pump was plumbed to recirculate most of the discharge flow for agitation in the main tank, while the remainder of the flow went to the large absorbent vessel for treatment. Figure A-6 shows the general arrangement of the jet pump and plumbing.

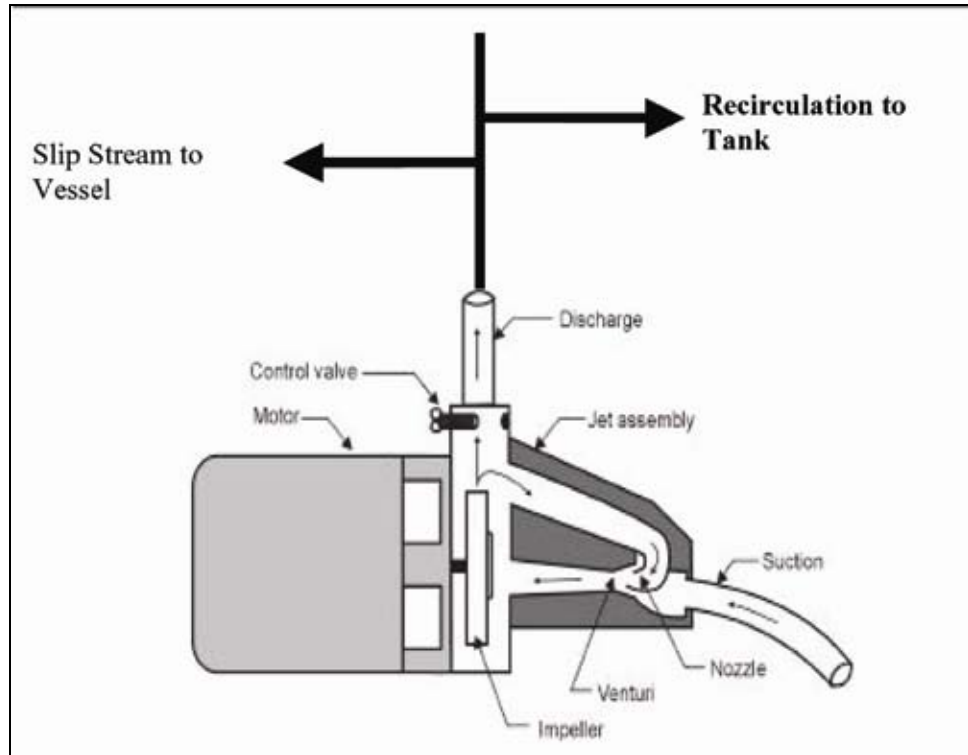


Figure A-5. Jet pump flow.



Figure A-6. Plumbing arrangement.

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The flow to the top of the large absorbent vessel was distributed via an open manifold to four branch inlets. The branched manifold allowed equal distribution of the waste stream over the top surface of the wood chips. The intent of the system was to provide a slow homogenous flow of grease trap waste to the top of the large absorbent vessel. Figure A-7 shows the first part of the branched manifold.



Figure A-7. Branched manifold.

Large Absorbent Vessel

The large absorbent vessel was a carbon steel cylindrical tank with a large auger mounted through the center axis. The vessel had grating to hold the wood chips above the cone-shaped bottom. The cylindrical tank was 6 feet tall and 4 feet in diameter mounted on 4-foot legs. The auger was 4 feet tall and 2 feet in diameter. An access door hinged in the front of the cylindrical tank allowed the operator to inspect the auger and to empty wood chips when they needed to be replaced. The top braces on the cylindrical tank support a 3/4-hp motor connected to a gear reducer drive and large double roller chain sprocket to turn the auger at approximately 1 revolution per minute (rpm). The counter flow absorbent column was directly under the large vessel and collected the liquid discharge. Figures A-8, A-9, and A-10 show the major components of the large absorbent vessel.

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Figure A-8. Large absorbent vessel.



Figure A-9. Motor and sprocket.



Figure A-10. Access door.

A front-end loader was used to move wood chips to the top of the vessel. The wood chips were of various sizes ranging from approximately 1/4 inch to 4 inches in length. The loader bucket was carefully positioned at the top of the large absorbent vessel, and the wood chips were shoveled by hand into the top of the vessel. The vessel was filled approximately two-thirds full. Figure A-11 shows the vessel after it was filled with the wood chips. The auger centered on the vertical axis of the vessel slowly turns and mixes the wood chips providing maximum surface area for grease adsorption, while preventing plugging by accumulations of grease. A scraper blade mounted to the bottom of the auger clears the grating in the bottom of the vessel, facilitating better flow. Figure A-12 shows the bottom section of the auger and scraper blade.



Figure A-11. Wood chips in the vessel.

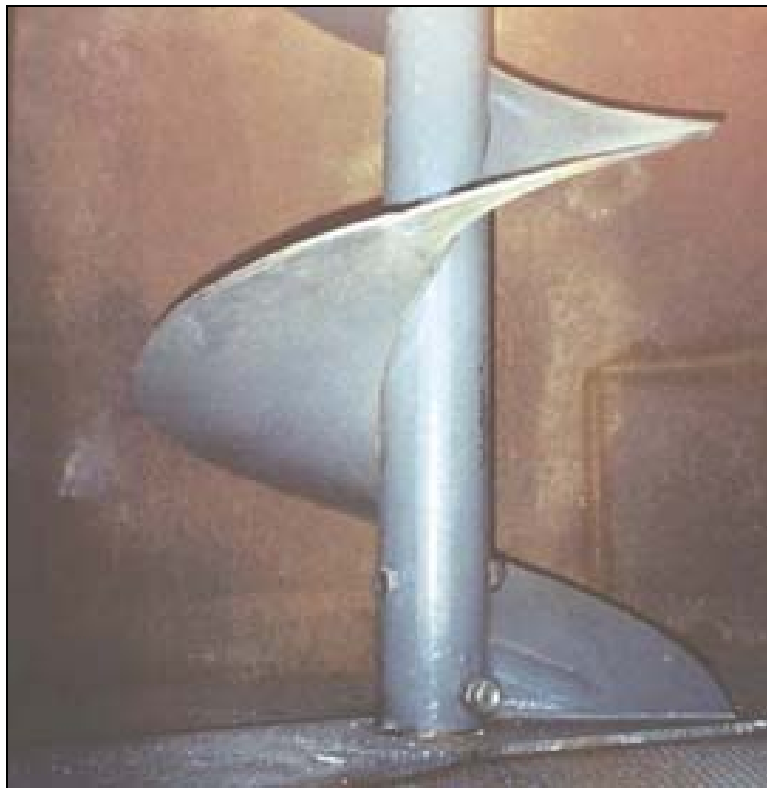


Figure A-12. Lower auger and scraper.

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Secondary Absorbent Conveyor

PIG DRI Absorbent material was used in the secondary adsorbent conveyor. The ingredients of the absorbent were 1% titanium oxide, 20% calcium carbonate, 30% kaolin clay, and 49% cellulose.

The secondary absorbent conveyor was a 5-inch-diameter steel pipe 10 feet long with a 4-inch auger throughout its entire length. The conveyor pipe was mounted underneath the cone section of the large absorbent vessel at about a 30-degree angle. Exit ports were at both ends of the auger pipe. Figure A-13 shows the general layout of the absorbent conveyor section. The high end of the conveyor holds a mounting plate for the motor and gear reducers. The auger is driven by a 3/4-hp motor through two gear reducers, rotating the auger at 1/2 rpm. Figure A-14 shows the motor end of the auger looking down from the upper end of the auger pipe.

The absorbent entered the lower section of the auger pipe by way of a flexible hose connected to the bottom of the absorbent hopper (see Figure A-15). As the auger slowly carried the absorbent up the incline of the auger pipe, grease trap waste wastewater trickled down through the absorbent. The water traveled along approximately 6 feet of the conveyor tube and was in contact with 4 feet of absorbent material. The water exited the lower end of the absorbent conveyor into the effluent water tank sump, and the spent absorbent exited out of the high end of the pipe into a 55-gallon drum. The effluent water was pumped into a 1500 gallon poly container (see Figures A-16 and A-17).



Figure A-13. Absorbent conveyor layout.



Figure A-14. Motor end of auger.



Figure A-15. Flex hose connection.



Figure A-16. Effluent water system.



Figure A-17. Sump bucket arrangement.

Observations Made During Operation of the System

General System Performance

There were operational problems with the system, most notably in waste storage and delivery, and with the secondary absorbent conveyor. These problems will be discussed further in the following paragraphs.

The wood chip adsorbent vessel worked very well at removing the grease from the grease trap waste influent. The wood chips were well coated and seemed to remove about 70% of the grease from the waste stream. The secondary adsorbent conveyor, however, did not work effectively, largely because the adsorbent material deteriorated during operation creating a nonporous, mud-like substance.

Grease Trap Waste Influent Delivery System

The two tanks provided by Fort Hood to hold a batch (approximately 1400 gallons) of grease trap waste for processing were essential because they allowed the waste to be fed to the treatment system at a constant rate. However, the grease trap waste did not effectively drain from the horizontal tanks unless sufficient agitation was provided by constantly recirculating the waste. Further, significant amounts of greasy material remained floating on the surface of the wastewater and were left in the bottom of the horizontal tank at the conclusion of the test. Removing this sludge would become a problem in a long-term operation.

A conical bottom tank may have worked better, allowing good agitation and pinpoint drainage. Figure A-18 shows an example of this tank type. The taller vertical shape would create a narrower cross section, allowing the recirculation stream to produce better agitation. The conical bottom vertical tank would also allow easy removal of floating sludge when necessary.

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Figure A-18. Cone bottom tank.

The small jet pump was economical and worked well enough during this pilot-scale test. However, other types of pumps may be better in future testing. A low-pressure, large cavity-type pump might have been a better choice for this application. A diaphragm pump, peristaltic pump, or progressive cavity pump might also be better options.

Large Absorbent Vessel

The large absorbent vessel functioned as designed with the wood chips absorbing grease and trapping food solids. The large auger also worked well by slowly churning the wood chips for maximum surface area exposure. The final drive and sprocket attached to the top of the auger provided more than sufficient torque to handle the wood chip load. In fact, the large absorbent vessel could have been filled to a higher level with wood chips. The wood chips themselves absorbed an unexpected amount of the grease. Visual observations of the effluent water indicated the wood chips separated and removed approximately 70% of the grease and solids from the free liquids. When the large absorbent vessel was emptied, the wood chips throughout the vessel tank were saturated in grease and did not have an offensive odor. Figure A-19 shows the wood chips still in the vessel, and Figure A-20 shows the wood chips in a drum ready for disposal.



Figure A-19. Wood chips in vessel.



Figure A-20. Wood chips in disposal drum.

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At the end of the 6-day test period, the wood chips were churned for 24 hours in the large absorbent vessel without feed water. After visual inspection of the expended wood chips exiting the large absorbent vessel, the material was judged to have no free liquids, so a paint filter test to check for free liquids was not conducted. Conducting the paint filter test, as defined in 40 CFR 264.314, would have entailed taking a sample of the grease-laden wood chips and placing them in a paint filter. If any liquid passed through the filter within the 5-minute test period, the wood chips would have contained free liquids by definition. Since solidified grease will not pass through a paint filter, the test was deemed unnecessary, and it was assumed that the spent wood chip media could be disposed of in the landfill.

The narrow opening between the top motor brackets on top of the vessel where the wood chips were loaded made loading the wood chips difficult. A funneling chute for use by a front loader, or a conveyor, might have made loading the wood chips easier. Unloading the wood chips was fairly easy, although it was done manually with a shovel. Closing the access door and rotating the auger periodically made this task even quicker. However, manual unloading could have been made unnecessary if a sheet metal spillway was attached to the bottom of the access door opening and the auger was able to run in reverse.

The bottom cone of the large absorbent vessel became blocked. It was thought the causes were the auger had no voids, and the auger speed was too slow. The scraper blade on the bottom of the big auger also tended to clear larger chips from the grate while pushing through smaller chips. The smaller chips escaping through the bottom grate to the cone had no exit path and packed the outlet area with absorbent. Eventually, the entire cone section was filled with smaller wood chips and completely obstructed. The auger tube and drive sections had to be completely disassembled to clear the cone section.

Generally, additional study is needed to improve the operation of the large adsorbent vessel. Both the influent and effluent portions of the structure need to be improved to accommodate better adsorbent loading and to prevent plugging in the outlet cone section.

Secondary Absorbent Conveyor

Problems were also encountered with the absorbent conveyor. The PIG DRI Absorbent performed well in a bench-scale column test at the MSE Testing Facility. However, the absorbent turned into mud

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inside the auger pipe, obstructing flow of the wastewater. Apparently the grinding effect created in the auger stressed and broke down the absorbent grains. Eventually the degraded absorbent blocked the entire length of the auger pipe.

Because the PIG DRI absorbent blocked the auger pipe and prohibited flow, the secondary adsorbent conveyor could not be evaluated. If there is a follow-up study, the second stage filter problem should be resolved to ensure the effluent water is filtered and free of smaller solids, emulsified oil, and smaller grease particles. Possible options are:

1. Optimize the adsorbent flow to water flow ratio,
2. Select a more appropriate type of absorbent material, or
3. Eliminate the secondary adsorbent step and increase the efficiency of the wood chip vessel.

Conclusions/Recommendations

The study showed that treating grease trap waste by absorbing grease and other solids onto wood chips is feasible. The pilot system had several operational problems, however, and the design needs to be revisited. Alternative and simpler treatment structures should be considered for applying the wood chip adsorbent technology. A more extensive pilot-scale demonstration is needed after new design recommendations are implemented. Fort Hood has plans to continue testing this treatment method on a larger scale; however, funding for that study is not yet available.

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