GUIDANCE FOR UNDERGROUND STORAGE TANK MANAGEMENT AT ULSD DISPENSING FACILITIES

INTRODUCTION

If a fuel storage facility is not properly maintained, bacteria and fungi can grow in the fuel-water interface, causing filter problems and deactivating the water monitoring system. With the exception of fuel with inadequate low-temperature fluidity (i.e., wax formation in diesel tanks at cold temperatures), most problems can normally be avoided by keeping the fuel storage system clean and as water-free as possible.

Water in the storage system can accelerate fuel degradation which should be avoided in order to assure vehicle performance and because it can increase sludge accumulation in the bottom of tanks. Contaminants such as salts in the water may cause the fuel chemical structure to degrade into components that may be detrimental to storage system components. These contaminants may also cause fuel additives necessary for maintaining the quality of the fuel distribution system to leave the fuel and enter the water.

Not only is water a problem in itself, but it is also the environment for biological growth within the fuel. Less than 0.25 inches of water is more than sufficient to promote microbial growth. Microorganisms live at the fuel-water interface and feed on the fuel. The presence of microorganisms can lead to filter-plugging, pump and injector problems, deactivation of the water monitor and buildup within the tank that is costly to remove.

IDENTIFICATION OF SYMPTOMS

When dispenser flow slows to about half its normal rate (at gas stations from 10-12 gpm to around 5 gpm or at truckstops from 30 or more gpm to about 15 gpm), it is an indication that the dispenser filter requires attention and needs to be replaced. However, reduced dispenser flows along with frequent filter replacement, constant system maintenance or customer complaints may indicate that a more systemic problem exists as opposed to routine maintenance. Signs of fuel or fuel system issues include plugged fuel lines, erratic gauge readings, a rotten-egg odor (of the fuel or filter), and frequent replacement of other components such as valves, rubber seals and hoses.

Figure 1 – Plugged Dispenser Filter vs. new

Issues contributing to the problem can sometimes be found by cutting open a clogged fuel filter and examining its contents. This can be done onsite or at an experienced laboratory. Solid or semi-solid

contaminants, microorganisms, water, or fuel quality problems (e.g., high paraffin content, fuel degradation, etc.) are the most likely causes of filter blockages.

Solid and Semi-Solid Contaminants—Solid contaminants, such as scaly, gritty deposits, consisting of reddish-orange metal, may be indication of corrosion and/or silt introduction into the tank. Black, brown, or other semi-solid particulates/deposits may indicate fuel product degradation.

Microbial Contamination—The presence of a foul (rotten egg) odor in the fuel or on a filter usually indicates the presence of microbial contamination. The presence of an inversion "rag" layer (Fig.2) from a tank bottom sample is a significant indication of microbial activity. Corrosion of interior metal filter parts may also indicate the presence of microbial activity. A non-uniform covering of a fuel filter (Fig. 3) or leopard spotting (Fig. 4) of a water coalescing filter is indicative of the presence of microorganisms. Since microorganisms need water to grow, microbial growth is always a direct indication of the fuel being in long term contact with a water layer in a storage tank.

Fig. 2

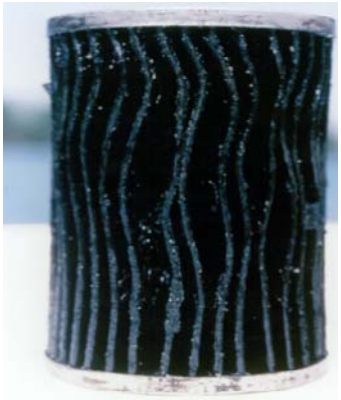


Fig. 3

Fig. 4

Photos courtesy of Fuel Quality Services, Inc.

MANAGING FUEL SYSTEMS AND FUEL DELIVERIES

It is recommended that facility owners/operators implement a simple and routine set of management and housekeeping practices to monitor and minimize fuel quality and fuel system issues. It is also recommended that facilities install a nominal 5 micron filter on the dispenser to ensure that fuel being dispensed to a vehicle is free of suspended particulate matter. If a fuel storage tank has chronic water accumulation problems, then a 5 micron water absorbing filter in an equivalent pore size may be required. Owners/operators should make sure tanks and piping systems containing different grades or types of products are isolated as independent systems.

Implementing routine management practices leads to reduced fuel quality and fuel system issues. For example:

- At Open and Close of Business:
  (1) Read all totalizing meters; (2) Gauge all tanks (either electronically or manually); (3) Check all tanks for water. If possible, remove any water greater than or equal to 1 inch; and, (4) Reconcile meter and tank readings by product system on a daily basis.

- Before and After a Fuel Delivery:
  (1) Gauge all tanks immediately prior to delivery and after delivery; (2) Remove standing water, ice/snow, and other debris from around the tank fill cover before allowing a fuel delivery into the tank; (3) After removing the tank fill cover, remove any and all water from inside the spill containment bucket; (4) All tanks should be checked for water before and after delivery; and, (5) All fill and gauge caps should be reinstalled, making sure that caps and gaskets are in good condition.

- After Delivery:
  (1) Calculate the amount of product received and compare with the amount shown on the invoice; (2) Make inventory adjustments for transactions during delivery; (3) Make sure fill and gauge caps are tight and locked. Consider sticking the tank a second time after receipt for water detection. The tank needs some time to settle-out, allowing any suspended water to separate and migrate to the tank bottom; and, (4) Make a special note and inventory adjustments for increase in water level.

- During Night Delivery when the Station is Closed:
  (1) Calculate the difference between the closing gauges and opening gauges and compare with the amount shown on the invoice; (2) Check the tanks for water at the opening of business following delivery and make necessary adjustments in previous day's water level; and, (3) Make sure fill and gauge caps are tight and locked.

- Daily:
  Visually inspect for leaks daily in tanks, piping, valves, pumps, meters, and dispensing equipment.

Monitoring Fuel Systems and Fuel Quality

The following activities can be implemented by a facility owner/operator to monitor and control fuel quality and fuel systems issues:

(1) Fuel Deliveries– Routine tank monitoring involves at least monthly testing for all tanks and extended quarterly analysis when fuel is not consumed and replenished within a 90-day cycle.

(2) Quality specification samples – If the State inspector or other sampler obtains a sample for quality testing, the owner/operator should ask them to capture an extra sample for their internal use. This extra sample could prove useful for the owner/operator and/or authorized fuel supplier.

In addition, tank inventory variances generally should not exceed 0.25 percent of product throughput over a one month period, or 2.5 gallons of every 1,000 gallons of monthly throughput. Monthly variances can be calculated from daily inventory control reconciliation data. If variances exceed 0.5 percent of throughput, a system leak may exist. Any tank operator whose losses exceed 0.5 percent of throughput over extended periods of time should carefully examine their operating practices and leak detection system.

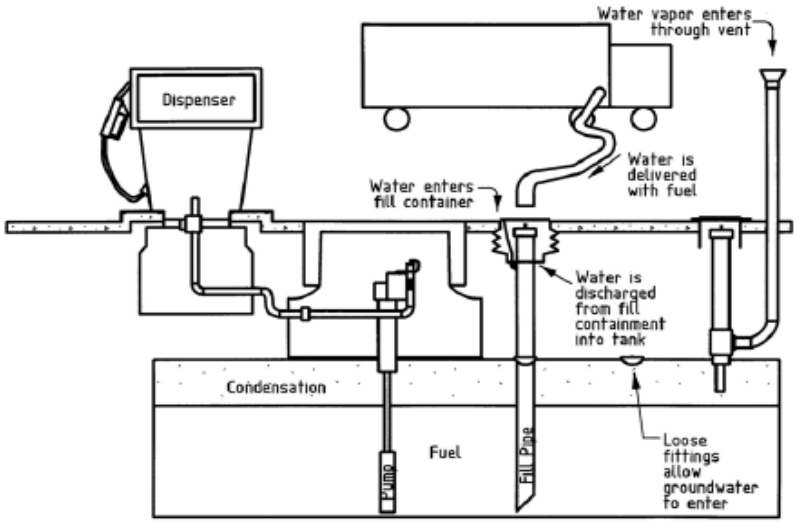
Records

Accurate records should be kept of all products dispensed for use on the premises or for the personal use of the operator and his or her employees. Notes regarding water inventory in storage tanks or due to fuel deliveries should be included in these records. Withdrawals must be properly accounted for if the stock control record is to show a true picture of inventory and losses. Samples from fuel monitoring activities and quality checks should be kept for period of time requested by the fuel supplier or until any investigations have concluded.

MANAGING AND MONITORING WATER-SPECIFIC CONTAMINATION

Background

The water level in a tank should be kept at a minimum, and not exceed local, state or federal guidelines. The chronic presence of water or increasing water levels can indicate a serious leak into the fuel storage tank and the need for tank tightness testing and appropriate corrective action. Tanks that have water due to fuel deliveries or general ingress should be checked quarterly to semiannually for microbial contamination. If microbial contamination is identified, then proper treatment and removal per local, state, and federal guidelines should be implemented.



Steel Tank Institute – Keeping Water Out of Your Storage System, March 2004

Water Entering the System

Water can enter the tank a number of ways, including:

- Condensation caused by humid air and fuel temperature swings;
- During transportation from refineries to service stations;
- Leakage through faulty fill pipes or vents, damaged spill buckets or fill cap gaskets, loose fittings or plugs;
- Allowing water captured in a spill bucket to be drained into the storage tank;
- High throughput in the fuel distribution/delivery infrastructure, allowing less time for water to settle out of the product before it's delivered into the distribution system from the refinery or as it's moved along the shipping process; and,
- Storm water runoff.

- In addition, fuels are more prone to water attraction and subsequent separation when subject to temperature swings. A fuel's composition and temperature affect the amount of water it can hold. Generally, the higher in aromatic content and the warmer the fuel, the more water it can hold in solution. That's usually not a problem until the fuel is cooled, causing the water to be released and settle at the bottom of a storage tank.

- The increased use of additives (i.e., lubricity additives in ULSD) may result in more polar compounds being available in the fuel which could increase the tendency for water to stay suspended longer. Since these additives are added at the part per million level, their impact on longer water suspension is not expected to have practical significance given that it is generally understood that ULSD holds less water compared to low sulfur diesel fuel.

Checking for Water in the Tank

If the type of monitoring equipment installed at a particular facility is unknown, the owner/operator should contact his/her petroleum equipment contractor and/or fuel supplier. They may be able to give information about what monitoring devices are installed on the storage system, provide reference as to where guidance may be obtained on operations and maintenance procedures, and advise on additional steps that should be taken. Simple manual tank gauging is one method of checking for water bottoms.

An automatic tank gauging (ATG) system with water monitoring capability is an ideal method, as long as the sensors are maintained to be functional. Some guidelines suggest comparing the product level reading taken with a manual tank gauge with that on the ATG because discrepancies may indicate water. For manual tank gauging, if there is no separate gauge opening, the tank-fill drop tubes must have no obstruction at the end of the tube which will interfere with gauging of water. Be aware of drop tubes with “floating striker plates” – these devices won’t show the last 0.75 inches of the tank bottom.

Owners/operators should check their storage tank for water as frequently as possible and, at a minimum, after each fuel delivery. In fact, some fuel providers suggest or require station operators to check daily for water bottoms. In addition to the simple procedures outlined above, periodic product samples from the inside tank bottom should be pulled and inspected. Check with the petroleum equipment dealer or fuel supplier for guidance on sampling devices and procedures.

Some basic guidelines for sampling the tank include:

- Pull samples from the low end of the tank if possible – tanks are often installed with a slight tilt to allow for water to collect in the low end.
- Be aware of the pitfalls of using the fill tube as the sampling port – if it is not located at the low end of the tank, sludge or water may never be detected. Also, if the fill tube is not installed straight, water and sludge may not be detected or it may appear that there is less water/sludge than there really is. Keep in mind that contaminants are continually washed away from the fill end by any new deliveries. For these reasons, the best place to sample a tank may be under the submersible turbine pump.
- If possible, samples should be taken from more than one location in the tank. The tank should have two openings—one at each end of the tank—for inspection and sampling purposes.

- If the fuel sample looks hazy, or waxy in cold weather, water is probably present. A field detection kit, available from petroleum equipment suppliers, can then be used to check the fuel for the presence of microbes and whether the fuel meets the appropriate fuel specification. Independent labs can conduct in depth analyses to determine the extent of any microbial contamination.

Manual Gauging Paste

A water-finding paste, which is unaffected by fuel but will change color in water, is used to check for water at the bottom of storage tanks. Information regarding a satisfactory paste may be obtained from a petroleum equipment contractor and/or a fuel supplier.

It is used as follows:

- Coat the end of a gauge stick on the graduated side with a thin, even film of the paste for approximately 3 inches from the bottom.
- Slowly insert the stick through the gauge hole until the stick reaches the bottom of the tank. Be sure that the stick is kept in a vertical position and that is does not rest on an obstruction or other projection on the tank bottom. Follow the guidelines accompanying the paste. Do not drop or bounce the tank stick on the tank bottom.
- Withdraw the stick and read the water cut (as noted by the change in the color of the paste) on the graduated scale to the nearest 1/8 inch.
- If the test shows 1 inch (or more) of water, make arrangements for the water's immediate removal. If the test shows water levels of 2 inches or more, the product should not be sold to customers until the water has been removed.

For a more accurate measurement, API recommends an average of two gauge readings that fall within ¼ inch of each other.

Preventing Water from Entering the Tank

- All fuel tank openings must be sealed against water intrusion and maintained in that condition by replacing gaskets, hatches, or vents as necessary.
- Any debris or water found around the fuel tank openings must be removed and disposed of in a proper manner before the opening is accessed.
- The tank fill area should be raised above ground level, supported by concrete and be placed outside the driveway area in order to minimize contaminants that could be carried in by vehicles or rain water.
- Vents must be constructed to minimize the entry of water and have a cap and screen if regulations permit. The vent screen should be inspected semi-annually.
- Suction must not be taken from the bottom of the tank but at a level recommended by the tank and/or dispensing equipment manufacturer (4-8" off the tank bottom is typical).
- Inspect product spill containment buckets – if liquid is present, do not drain it into the tank but instead, remove and properly dispose of it.
- Ask the fuel supplier what measures are taken to ensure fuel is delivered without water.

Preventing Microbial Growth

The following practices should be conducted by owners/operators of storage systems to mitigate microbial contamination:

- Watching for slower fueling because microbial contamination can contribute to clogged filters.
- If 1 inch (or more) of water is detected in the bottom of the tank, remove it.
- Contact the fuel provider or a qualified consultant to understand how to establish a surveillance program to detect and remediate microbial contamination. Tanks should be checked quarterly to semi-annually for microbial activity and treated accordingly with an effective biocide. Make certain that the biocide selected for use is EPA approved and that the supplier is knowledgeable about treatment protocols and handling. The tank should be treated at a high inventory level with time allowed for treated product to move through the entire fueling system and for microbial waste to fall to tank bottom (with correct filtration in place). After treating the tank, a tank and product cleaning should take place. In particularly serious cases, additional treatment after the initial treat/clean cycle may be warranted.
- Periodically examine and maintain the inside of the tank using professional contractors, removing any water and sludge.
- As an added safety measure, have the tank periodically cleaned by qualified professional contractors. (The frequency depends upon the level of contaminants in the fuel, how fast the fuel is sold and the tank refilled, and other factors.)

TANK CLEANING

Have the tank properly cleaned if a significant amount of tank bottom sludge and/or metallic material is found. The product pumped out from the bottom of the tank shall not be reloaded into the tank after cleaning since it is contaminated product. Monitor the tank closely after the tank cleaning, and track deliveries from terminal supply points. Increases in the water level inside the tank after rain events may indicate there may be an issue with tank integrity or drainage problems on the pad surrounding the fills.

If sites receive approval from their fuel provider and choose to proceed with additional treatment with biocides, this additional step should only be applied after tank cleaning is complete. Contact a qualified, reputable professional with expertise in microbial contamination control. They will work with the owner/operator to develop the best plan of attack. Whenever microbial growth is present, remediation should be performed.

CONVERSION

If a tank is to be converted to diesel fuel service from some other fuel service, the tank and its related dispensing equipment must be thoroughly cleaned, inspected, and verified compatible with diesel fuel. Care should also be taken to make sure gasoline was not commingled in the tank truck, storage tank, or in the vehicle fuel tank.

When switching to ULSD or Biodiesel, care should be taken as if the new fuel will have a cleansing effect on the fuel tanks and will lead to a shorter fuel filter life. After conversion the filter life should return to normal.

Conversion without proper tank cleaning often results in the loosening of prior deposited sludge and debris that will reduce flow and plug screens and filters.

The following comprises a checklist that should be used when converting storage and dispensing equipment:

Prepare for transition by taking the following steps:

- Check that all components listed in this section are suitable for use with the proposed fuel by verifying material compatibility with a third party certification, or with proof from their respective manufacturers.
- Check the nationally recognized testing laboratory listing for each component, and examine the standard to which the equipment was listed, being mindful that not all standards address material compatibility.
- Confirm that all required approvals for the equipment are in place.
- Review the water infiltration history of the site using tank inventory records. Investigate any instances that indicate that groundwater or runoff from heavy rainfall may have entered the tank, and correct any defects.
- Inspect fill pipe and vapor return fitting caps and gaskets for wear and cracking. Replace if necessary.
- Inspect the submersible pump sump, spill bucket and spill containment covers to assure that they are in good condition and will prevent water entry.
- Check the submersible pump suction height. The recommended level is between 4 in. and 8 in. from the bottom of the tank.
- Check that the product and vapor spill bucket are clean and dry.
- Inspect the drain valve, if present, in each spill bucket to assure that it is liquid and vapor tight. A leaking drain valve can allow water in the spill bucket to drain into the tank and contaminate stored product. All fittings and connections at the top of the tank must be tight to prevent vapor escape or entry of water into the storage tank. Take corrective action if necessary.
- Verify that the steel vent line riser is not corroded at the base where water could intrude.
- Confirm with the manufacturer that automatic tank gauging probes, floats, and sump sensors will perform properly with the designated fuel.
- Prior to initial delivery of the new fuel, draw down the fuel level in the tank as low as possible. This may be accomplished by vehicle refuelings through filling station dispensers.
- Remove all water and sludge from the bottom of the tank. If the tank is tilted away from the fill end, it may be necessary to remove the submersible pump to remove all contaminants. If water is present, determine the means of entry and rectify. Clean the tank if all contamination cannot be removed or if internal inspection or repair is needed.
- If the tank is tilted, confirm whether the stick readings are taken on the high or low end. Consideration should be given to moving the stick gauging location to the low point of the tank to detect and measure the water level accurately. When making measurements, confirm that the stick readings are to the tank bottom and not to an elevated striker plate.
- Adjust the water float on the automatic tank gauge to detect water at the lowest level.
- Obtain compatible water detecting paste for use with gauge sticks. Dispose of any incompatible pastes in a safe manner.
- Identify and properly label the fill and vapor recovery connections, access covers and dispensers with the new product description.
- Change the dispenser filters and/or clean the dispenser strainers prior to switching fuels. Consider the installation of filters that can detect the presence of water to alert for phase separation.
- Perform liquid and vapor tightness tests on the tank system following the equipment manufacturer recommendations or permit requirements.

- Biodiesel blends may act as a solvent and loosen sediment and sludge from tanks and product lines. Tanks should be clean and free from water.

After receiving the first load of new fuel take the following steps:

- Before allowing sale of product, manually gauge the tank using compatible water detecting paste. If water is detected, do not allow any sales. Determine the cause of the water and resolve it.
- Some fuels containing biodiesel may act as a solvent and will loosen sediment and sludge from tanks and product lines. Tanks should be clean and free from water and sediment before the introduction of the first load of a new fuel. Fill the tank with the conversion load of new product to 80% capacity. If the desired tank level is not accomplished with the initial load, a second load should be brought in immediately after. The high product level allows the fuel to loosen sediment and varnish deposits from the sides and upper portions of the tank. Keep the tanks as full as possible during the first seven to ten days after conversion to accelerate the deposit removal process. Tank operators should be alert that the tank cleansing effects of some fuels may reveal tank defects which may lead to product releases.
- After beginning new fuel service, inspect delivery fittings, dispenser interiors, hoses and nozzles daily for any evidence of leakage from the shrinkage of gaskets and sealants or other causes. Take corrective action if necessary.
- Monitor the dispensing rate of each nozzle daily for 10 days to 14 days after conversion. A reduced flow rate of less than 5 gpm most likely indicates that the dispenser filter has become plugged and should be replaced. If the flow rate does not return to its normal rate (at gas stations 10-12 gpm or at truckstops 30 gpm), check the dispensing system for contamination.
- During the initial phase of operation after the introduction of a new fuel, higher than normal dirt loads in the stored product can be anticipated. The increased level of contamination may cause filter clogging and reduced dispensing rates. Therefore, the frequency of filter cleaning and strainer basket replacement should be increased. Assure that applicable safety procedures are followed when changing filters and strainer baskets.
- Check the calibration of dispensing meters 10 days to 14 days after conversion to ensure that the product change has not affected meter accuracy. Confirm meter accuracy again two to three months after conversion to check for accelerated wear.

CAUTIONARY NOTES

Tanks should be checked for water after a thaw or heavy rain to detect water that may enter the tanks through leaking fill or gauge caps.

Lower throughput tanks:

- May be more susceptible to water accumulation, such as low throughput service stations, fleet fueling sites and other commercial or industrial UST or AST sites. The lower the throughput at a storage and dispensing site, the more likely water may accumulate in the system.
- Unused fuel degrades with time and chemical changes and reactions will occur. For tanks that retain the same fuel for 90 days or more, additional quality testing should be performed.

When inspecting the tank or sampling fuel from the tank, do not leave the opening unattended or exposed to the elements.

Occasionally, a submerged and/or suction pump will deliver water with the product, but no water will show when the tank is checked. This usually indicates that the tank is not level and the water has

accumulated at the low end away from the gauge well. Similarly, a suction pump may dispense water with the product when there is an underground suction line leak and a high water table. Such a condition must be checked and corrected immediately. Some long tanks are equipped with a gauge well at each end and water may be found only under the lower end. A tank equipped with only a center gauge well may not show accumulated water if the tank is not level.

Tanks and piping, all other metal components in direct contact with the ground that routinely hold product — such as flexible connectors, swing joints, fittings, and pumps — must also be cathodically protected.

Biodiesel fuel should not be stored for longer than six months as fuel stability of this product is unknown. Per ASTM International's Standard Specification for Diesel Fuel Oils, D975, ULSD sold at retail may contain up to 5% biodiesel.

Shipments received via barge should be monitored for the presence of microorganisms. Electrochemical/corrosion experiments have shown that the anaerobic microbial metabolism of biodiesel in coastal seawater samples accelerate the rate of pitting corrosion in carbon steel.

SOURCES

American Petroleum Institute RP 1621, Bulk Liquid Stock Control at Retail Outlets

American Trucking Associations, Technology and Maintenance Council (TMC) RP 345A, Diesel Fuel Housekeeping Guidelines / RP 518, Fuel Station Planning

Publically-Available Tank Maintenance Documents

Steel Tank Institute's "Keeping Water Out of Your Storage System"

EPA's "Operating and Maintaining Underground Storage Tank Systems: Practical Help and Checklists"