

## **GAUGING, TESTING AND RUNNING OF LEASE TANKS**

Class # 2200

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### **Introduction**

Many production sites do not have metering facilities for custody transfer. Metering facilities require additional capital expenditures but minimize the labor costs over the life of the lease. If metering is not available at the field location the custody transfer measurement is generally performed by manual tank gauging. In this case, after gauging the tank can be emptied into a truck or into a pipeline. Another method which is used occasionally is to have a meter on the truck which serves as the custody transfer. However, the majority of locations which do not have a LACT (Lease Automatic Custody Transfer) Unit utilize the tank gauge as the means of custody transfer.

The procedure for gauging of tanks is covered by API (American Petroleum Institute) MPMS (Manual of Petroleum Measurement Standards) Chapter 3 in general and Chapter 18 specifically for tanks gauged from a lease facility and the products trucked. Verification of the equipment utilized in the gauging process against certified test standards which are traceable to the NIST is now required for all of the equipment utilized to gauge the tank.

### **Gauging of Lease Tanks**

Prior to gauging a tank, the tank should be isolated. The inlet, equalizing and outlet valves should be closed and sealed. During the gauging of a tank, it is important not to contaminate the fluid in the tank to be measured. The methodology is known as the column of oil concept, and involves working the tank from the top to the bottom in a systematic way. The pipeline gauger should verify the tank is in good condition and has no leaks. The gauger should also be aware of all safety precautions which should be taken. These include being aware of potential static electricity buildup as the tank is climbed, proper handling and grounding of equipment, etc. The gauger should always wear the proper safety gear and note if any hydrogen sulfide is present and take necessary precautions if it is. The gauger should follow all regulatory and company safety procedures.

The gauger should record the tank number of the tank to be gauged and note the outlet level and reference height. The first actual gauging task will be to insert the cupcase thermometer into the middle of the oil column as far from the tank shell as possible. In order to insert the cupcase thermometer, the gauger should open the gauge hatch carefully looking away. After verifying the oil layer is still, the cotton line will be tied off so that the cup case thermometer is suspended in the middle of the oil column for a minimum of ten minutes if the gravity exceeds 50 degrees API. For gravities which are less than 20 degrees API the immersion time is a minimum of 80 minutes if the thermometer is stationary. The immersion time is specified for gravity ranges in Table 1 of API MPMS Chapter 18. While the cup case thermometer is coming to an equilibrium temperature with the oil in the tank, additional gauging tasks can be performed. API MPMS Chapter 7.1 Static Temperature Determination Using Mercury-in-Glass Tank Thermometers provides complete details of the proper procedure to be followed if there are any questions. The thermometer is read to the nearest one degree.

The next task is to obtain the proper samples for the API gravity determination and the sediment and water determination. The proper sampling techniques are fully described in API MPMS Chapter 8.1 Manual Sampling of Petroleum and Petroleum Products. Typically a thief is utilized to obtain the proper samples from the tank.

Since we do not want to contaminate the contents of the tank, the gauger will first obtain the upper sample. The number of samples required is a function of the size of the tank. If the tank is less than 1000 barrel capacity which is typical for small lease tanks, then three samples are required. The first is an upper sample which is taken in the middle of the upper third of the oil column. This sample is utilized to determine the sediment and

water of the tank. Next a middle sample is taken to obtain the observed gravity and temperature utilizing a thermo-hydrometer. Finally an outlet sample is obtained to determine the sediment and water in the lower portion of the tank. Typically, a clearance sample is taken at the same time, if the thief has sample petcocks, then one is set up to be the outlet sample and another for the clearance sample.

The samples are obtained by utilizing a bottom closure thief. Many companies utilize a modified bottom closure thief which provides sample cocks at various locations. Frequently, a sample cock will be located at the 12 inch, 8 inch and 4 inch points. The sample cock locations make the obtaining of the bottom sample later in the process more convenient. The gauger will lower the thief and trip the closure in order to obtain the necessary sample for later testing at each location, working from the top of the tank down to the bottom required sample. Oil from the thief will be utilized for the sediment and water determination and the gravity determination. If sample cocks exist on the thief, the sample for sediment and water can be taken from a sample cock directly into the centrifuge tubes for testing later. Once the middle sample is obtained the thief is hung from the gauge hatch and the proper range thermo-hydrometer inserted. The thermo-hydrometer should be floating freely away from the sides of the thief and allowed to reach thermal equilibrium. Read the hydrometer section to the nearest 0.1 degree and remove the thermo-hydrometer from the thief leaving the tip in the oil to maintain temperature. Read the temperature section of the thermo-hydrometer to the nearest 1.0 degree Fahrenheit. API MPMS Chapter 9.1, Hydrometer Test Method for Density, Relative Density (Specific Gravity) or API Gravity of Crude Petroleum and Liquid Petroleum Products should be consulted if there are any questions. Ultimately, the observed gravity and temperature will be converted to API gravity for the final calculations.

After the samples are obtained for the quality determination, a clearance sample is obtained to verify that there is clean oil at least 4 inches below the pipeline outlet. The level of the tank outlet is written on the side of the tank. Extend the trip rod the proper amount to obtain an outlet sample. If the modified thief is utilized this will be simplified, by setting the stinger such that the middle sample cock is at the bottom of the tank outlet. The lower sample cock should then automatically provide the 4 inch clearance if it is positioned 4 inches below the middle sample cock. Obtain the sample and transfer the sample using the sample cock into a centrifuge tube or other suitable container for later testing.

Pipelines require a minimum of 4 inches of merchantable oil below the pipeline outlet and the level of bottoms or free water. The clearance level can be determined visually, by pouring the sample over a gloved hand or smooth object back into the tank until a color change is noted or free water is observed. If it is uncertain whether or not there is at least 4 inches of clearance by visual means the test can be determined by the centrifuge method which will be described in the testing section. The tank should not be run if there is less than 4 inches of clearance. The producer should be contacted if not witnessing the test and informed the tank requires cleaning.

The samples taken with the thief should be representative of the contents of the tank. Care should be taken to insure that the contents of the sample remain representative of the tank contents prior to testing.

The volume within the tank is determined by tank gauge. This requires an opening gauge when the tank was full and a closing gauge when the tank has been emptied. The gauge height is converted to observed volume by utilizing the tank table for that tank. The difference in the two quantities is the volume of oil transferred and will be corrected to standard temperature.

The gauge line should be lowered slowly through the tank while maintaining contact with the reference point on the gauge hatch. Ensure that the bob remains in the vertical position when it touches the datum plate or the tank bottom if the datum plate is missing. Otherwise an inaccurate opening gauge will be obtained. Once the bottom has been reached, raise the gauge line until the liquid cut is reached. Read the gauge line at the point of the liquid cut. Wipe off the gauge line and repeat the process until two consecutive readings repeat. The gauge line should be read and recorded to the nearest quarter inch on all tanks less than 1000 barrels.

Once the opening gauge is complete, remove the cupcase thermometer and read the temperature. The temperature should be recorded to the nearest one degree. It is important to minimize the exposure to wind and to keep oil in the cup in order to obtain an accurate tank temperature.

### **Testing of Lease Tanks**

The samples taken during the gauging process are used for determining the gravity if not obtained at the top of the tank and the sediment and water content of the crude oil or product. Generally the gravity is determined at the top of the tank, but if conditions are difficult the sample can be obtained and the test can be performed on the ground in a more protected area.

The sediment and water determination is performed based on API MPMS Chapter 10.4, Determination of Sediment and Water in Crude Oil by the Centrifuge Method (Field Procedure). In order for this test to be accurate, the sample collection and sample handling must be performed properly. The sample should be representative of the crude oil in the tank and should not be contaminated in any way. It is best to transfer the sample directly into the centrifuge tube if possible. This eliminates one transfer and possible contamination point.

If the sample is transferred into some other container, it must be properly mixed prior to transferring to the centrifuge tubes. If the sample is representative and the API procedure for the centrifuge test is followed correctly, accurate results will be obtained. The crude oil should be placed in the centrifuge tube prior to any solvent being added. This is to allow correction of the quantity of crude oil in the centrifuge tube. The tube should be filled to the 50 ml or 100 part mark depending on the demarcation on the tubes. If not enough is in the tube more can carefully be added to obtain the proper amount. If too much oil is put in the tube, then some can be removed without affecting the test. However, some gaugers fill the tube with solvent first. Technically, if the wrong amount of oil is put in after the solvent, nothing can be done to correct the situation without getting another sample. The test is intended to have 50 per cent oil and 50 per cent solvent. Otherwise the reported sediment and water will either be under reported if not enough oil is in the centrifuge tube or it will be over reported if there is too much oil. Once the solvent has been added, stopper the centrifuge tubes. Invert each tube a minimum of 10 times to mix the crude oil and the solvent. Place the tubes in the preheater after loosening the stoppers and heat them to 140 F +/- 5 F.

Place the centrifuge tubes in the centrifuge opposite each other, to balance the centrifuge. Centrifuge the tubes for a minimum of 5 minutes. Check the temperature of the tubes, if the temperature is above 125 F the tubes can be removed and read. If the temperature is below 125 F, the tubes must be reheated and re-centrifuged until a greater than 125 F temperature is obtained.

The proper reading is the top of the meniscus. If tubes marked with 100 ml at the top are utilized, the actual sediment and water is the sum of the readings from the two tubes. If tubes marked with 200 parts are used, the correct sediment and water result is the average of the two readings. Record the sediment and water readings of each tube.

The tubes should be returned to the centrifuge for an additional 5 minutes of spinning. Repeat this process until two consecutive consistent readings are obtained on each tube.

If the sediment and water obtained by the centrifuge method exceeds the allowable sediment and water limit the tank should not be run. The producer should be notified that the tank should be cleaned. If the results are below the allowable limit, then the tank should be prepared to be run.

### **Running of Lease Tanks**

Once the gauging and quality testing is completed and the tank is acceptable for delivery into the pipeline it is time to prepare the tank for actual custody transfer or movement from the tank into the pipeline or truck. At this time, the gauger should make sure that all the other valves on the outlet manifold are closed and sealed. The seal on the outlet valve of the tank that is now ready to be run should be broken and the seal number recorded. The valve should be opened. All valves in the piping entering the tank should still be closed. The outlet valve is frequently sealed open during the actual transfer of crude oil.

The Run Ticket which is a legal document should now be filled out with the opening information. Care should be taken to make sure that all of the information is properly recorded as this information will be utilized to calculate the actual quantity of oil sold. Common errors are frequently due to transposition of numbers. If a witness is present, the witness should sign the run ticket as well.

After the tank has been emptied, it is time to obtain the closing gauge information. The first order of business is to close the outlet valve and reseal it. The seal number should be recorded on the run ticket. Next the closing gauge should be performed in the same manner that the opening gauge was performed, except no samples will be required. The closing tank temperature should be obtained as well. The gauger should also inspect the internals of the tank to determine if there is any encrustation which would affect the tank gauge. The tank can now be put back in service by opening the inlet valve. Once off the tank, the gauger records the closing tank gauge and temperature on the run ticket. The run ticket should be reviewed to assure that all data is accurate. At this point, the custody transfer process is complete. Copies of the run ticket should be made available to both the producer and the transporter.

Accurate custody transfer measurements are achievable if the API MPMS measurement practices described in this paper are properly performed according to the standards. Proper training of gauger personnel helps to provide knowledgeable competent gaugers.