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THE ECONOMICS OF LEASE AUTOMATIC CUSTODY TRANSFER

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Introduction

The two most common methods of measuring the volume of petroleum liquids are tank gauging and liquid metering. The problems associated with tank gauging are (1) it requires that an operator make an accurate liquid level determination by climbing to the top of the tank to be gauged, (2) that an operator make an accurate average liquid temperature determination, (3) that an operator make an accurate sediment and water content analysis and (4) that the tank be static, which means that no liquid can enter or leave the tank during gauging. Once the contents of the tank are removed, it is necessary to regauge the tank.

Since crude oil is sold on the basis of temperature, API Gravity and the amount of Basic Sediment and Waste (BS&W), it is very important to make accurate measurements. The greatest effect on volume is temperature — typical crude oil will expand and contract at the rate of 2% per 40º F temperature change. The accumulation of errors present in the tank gauging may be as high as 1%. The potential annual losses in revenue, based on daily lease production and on $50.00 USD per barrel oil, would be as follows:

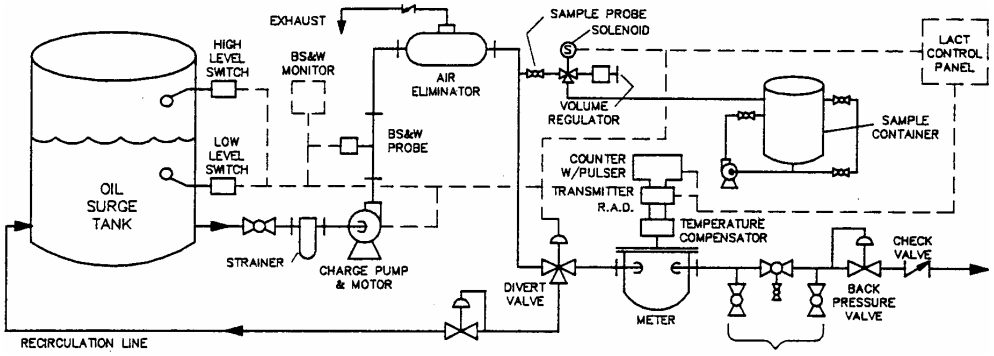
DAILY LEASE PRODUCTION	LOST REVENUE PER YEAR @ 1%
500 Barrels	$91,250.00
1000 Barrels	$182,500.00
2000 Barrels	$273,750.00
3000 Barrels	$547,500.00

The simplest and most effective way to transfer the ownership of liquid hydrocarbons between a buyer and a seller is through the use of an accurate liquid meter. With the aid of additional components, the liquid meter is capable of unattended measurement with maintained accuracy's of 0.25%, or better. This measurement system is commonly referred to as a Lease Automatic Custody Transfer (LACT) Unit when ownership is transferred at a production lease. When ownership is transferred away from a production lease, such as a transfer between Pipeline Companies, a measurement system may be referred to as an Automatic Custody Transfer (ACT) Unit.

Typical LACT Unit

A typical LACT Unit would include the following major components:

TYPICAL L.A.C.T. SCHEMATIC



1. Charge Pump and Motor — The pump is the primary energy source for the entire system.

2. Strainer — The strainer is a device that houses a removable perforated basket that is designed to collect solid materials that may be present in the flowing stream.

3. Air Eliminator - An air eliminator is a device that is used to remove entrained air or vapor from the fluid stream before it enters the meter. Should air be allowed to enter the meter it would be measured as part of the flowing stream, resulting in meter inaccuracy.

4. BS&W Probe and Monitor - An electronic device that is capable of determining the amount of Basic Sediment and Water (BS&W) is an integral part of most LACT Units. The system consists of an inline "BS&W Probe" that monitors the entire flowing stream and communicates to an electronic device, called a "BS&W Monitor" that produces an electrical control signal based on the amount of BS&W present in the flowing stream. The ability of this system to signal the LACT Unit on excess BS&W content insures that only the highest quality of "Merchantable Oil" is delivered to the Transport Carrier or the Pipeline Company. The electrical control signal feature of the BS&W Monitor is used to control a diverting valve that diverts the fluid stream back to a retreating facility whenever the BS&W content exceeds the Monitor setting.

5. Diverter Valve — The diverter valve is a three—way, two— position valve that is installed upstream of the meter and used to direct total fluid flow to either the meter or to the retreating facilities. The valve position is dependent upon the amount of BS&W in the flowing stream. When the Unit is shutdown or an excess amount of BS&W is detected, the valve is positioned for a normal divert or "fail closed" position. When the LACT Unit is running and the BS&W content is below the BS&W Monitor setting, the valve is positioned to a "run" position to allow total fluid flow through the meter.

6. Sampler System — The sampler system consists of a probe that is used to retrieve a representative sample of the flowing stream and a sampler container that is used to store the collected samples over a specified time period. The contents of the sample container are used to determine the true representative value of the entire metered stream during the custody transfer. The representative sample contents will determine composite API Gravity and the total percentage of BS&W.

The sample container is a storage vessel that is used to collect the contents of all the samples taken and is sized to allow adequate storage during the total custody transfer period, usually 30 days. It is important that the container be vapor tight to prevent the evaporation and loss of entrained vapors that could affect the composite API Gravity -thus affecting the total value of the product.

7. Meter — The meter is used to accurately and precisely measure the total fluid stream and to accumulate the total throughput. The most accurate meter used is the positive displacement meter. The positive displacement meter uses the energy of the flowing stream and divides the stream into small segments through rotation of an inner unit. This precise rotation is connected through a mechanical gear train to a mechanical counter to develop the total throughput of the LACT Unit. In order to provide the many functions required, the following meter accessories may be used:

   a. Automatic Temperature Compensator — used to mechanically correct meter registration to a base of 60 degrees F.

   b. Low Resolution Transmitter — used to electrically actuate the sampling system.

   c. Right Angle Drive - used to mechanically connect the gear train of the meter to a portable high resolution photoelectric transmitter that is used for meter proving and calibration.

   d. Counter — a non—resettable type mechanical counter used to accumulate the total throughput of the LACT Unit.

   e. Meter Monitor Pulser — an electrical transmitter that is mechanically attached to the counter to alarm the LACT Control Panel anytime the meter is not turning and the LACT Unit has been signaled to operate.

   Other meter accessories may be employed on a LACT Unit depending on the application. In some cases, electronic Temperature Averagers may be used in lieu of the mechanical temperature compensators.

8. Meter Prover Loop — The meter prover loop is a manifold using three valves connected to two tees. The typical arrangement is to install the valves and tees so that two of the valves are side mounted and one valve is inline. This arrangement allows another meter or “prover system” to be connected to the side mounted valves. By closing the inline valve, all fluid going through the meter would also go through the prover system. The inline valve becomes the “inline prover valve” and since every drop that goes through the meter must go through the prover system, it is necessary that this valve have special internal seats and seals so that any seal leakage can be detected.

   The tees that make up the meter prover loop are furnished with thermowells and pressure gauges that are used to compare flowing temperatures and pressures with the prover system during meter calibration.

9. Back Pressure Valve — The back pressure valve is an automatic valve that is used to hold a minimum pressure against the entire LACT Unit. This valve is required to ensure that the meter always operates against a pressure above the vapor pressure of the fluid being metered. Vapor pressure is the minimum pressure and temperature required to maintain the product in the liquid state. When a centrifugal charge pump is used, the back pressure valve holds a constant pressure against the rump that maintains a constant flow rate on the meter. Provided the back pressure setting is always above the vapor pressure of the fluid, it is possible to adjust flow rate through the meter by adjusting the valve.

10. Check Valve - A check valve is used to prevent backflow of metered fluid from the Transport Carrier or pipeline back through the LACT Unit. The check valve is installed as the last device in the piping system. The check valve is a two-way type valve with a hinged flapper that allows fluid to pass through the valve in one direction only.

11. LACT Control Panel - The LACT Control Panel is the electrical brains of the LACT Unit and controls the entire operation of the system. The basic system operates on liquid level switches installed on the "run tank" or "surge tank". When a high level is signaled in the run tank the LACT Control Panel will start the charge pump. Provided there are no problems during operation, the system will run until a low liquid level is signaled and the unit will shut down until the next high level signal is received. In addition to starting and stopping the LACT unit from level switches, the following features are also provided;

    a. Main Power On—Off — a circuit breaker or fused disconnect switch to be used to remove power from all electrical devices on the LACT Unit.

    b. Hand-Off-Automatic Switch - used to run the LACT charge pump in a manual or automatic mode.

    c. Lightning Arrestor - used to help absorb the electrical surges from lightning.

    d. Divert Controls — used to position the diverter valve based on signals received from the BS&W Monitor.

    e. Monitor Failure control — used to shutdown the system in the event of a failure of the BS&W Monitor.

    f. Meter Malfunction Control - used to shutdown the system in the event the meter does not register when the LACT Unit is in operation.

    g. Set Stop Allowable Control - sometimes used to shutdown the LACT Unit if a preset quantity of product has been delivered through the system.

    h. Alarm Beacon — used to alarm an operator anytime there is a failure on the LACT Unit.

12. Sealing - Any device that affects the quality or quantity of the measurement of the LACT Unit must have a means of security sealing. Such items would include the BS&W Monitor, the Sampler Probe and Sample Container valves and components, Meter and Meter Accessories, Prover Valves, Back Pressure Valves and the LACT Control Panel.

Meter Proving And Calibrations

In order to insure accurate custody transfer, through liquid measurement, it is necessary to maintain the metering equipment and to perform periodic meter calibrations. Liquid meters are capable of a high degree of accuracy, but must be calibrated using a known standard. Meter calibrations are performed in place under near operating conditions and are usually performed on a monthly basis and provided by the purchaser or as agreed upon by a third party. The periodic meter calibrations are provided to compare the actual meter throughput to a known volumetric standard such as a bi-directional meter prover. Because the total throughput through the meter since the last meter calibration will be adjusted, based on data obtained from field calibration tests, it is recommended and suggested that the seller provide a qualified witness to be present to observe and verify all data and field tests.

The established volume of a bi-directional meter prover system is determined from a precise calibration using volumetric measures that are traceable to the National Institute of Standards and Technology (NIST). Accurate displacement of the liquid is accomplished by forcing a spheroid through the calibrated section of pipe using fluid energy from the stream being metered and recording the metered volume. Since the entire stream of fluid being metered flows through both the meter and the prover, a ratio known, as "meter factor" can be determined between the known volume and the volume registered by the meter. This meter factor is used as a multiplier and applied to the volume shown on the meter register to determine true quantity of fluid passing through the meter.

The advantages of the bi-directional meter prover system are that proving is done under actual operating conditions and the meter runs continuously. This procedure eliminates errors resulting from starting and stopping and also reduces proving time. Another advantage is that proving temperatures are stabilized during continuous proving.

Economics

A typical 2" LACT Unit has a nominal capacity of 2000 barrels per day with an installed price of approximately $45,000.00. Assuming an improved accuracy between tank gauging (1%) and LACT Measurement (0.25%), the following tabulation would favor the use of LACT Measurement:

DAILY LEASE PRODUCTION	LOST REVENUE FROM GAUGING PER YEAR @ 1%	LACT UNIT MEASUREMENT ACCURACY 0.25%	ADJUSTED LOST REVENUE PER YEAR
500 Barrels	$ 91,250.00	$ 22,812.50	$ 68,437.50
1000 Barrels	$182,500.00	$ 45,625.00	$136,875.00
2000 Barrels	$365,000.00	$ 91,250.00	$273,750.00
3000 Barrels	$547,500.00	$136,875.00	$410,625.00

Based on the "Adjusted Lost Revenue Per Year", the payout on a 2" LACT unit would run between a maximum of one year and a minimum of four months depending upon total lease production.

Conclusion

Accurate Custody Transfer requires precise measurement functions. In the case of tank gauging four functions are required — level, temperature, API Gravity and BS&W. All these measurement functions must be manually performed by an operator. The accuracy of these functions are dependent upon the technical ability of the operator and upon the equipment available to him. Another area of concern is the growing number of environmental regulations being imposed upon lease operators. One such regulation is the new Occupational Safety Act (OSHA) that now requires two men be available for gauging due to the potential hazards of Hydrogen Sulfide Gas.

The economic advantages of LACT Measurement would include the following:

1. Improved accuracy through the use of more precise measurements of volumes, temperature, API Gravity and BS&W.

2. Unattended operation by eliminating an operator being on hand during delivery. An operator only needs to be on hand to witness meter proving or provide routine maintenance.

3. Reduced installation cost through the use of smaller run tanks.

4. Cost saving by consolidation of tank batteries where practical.

These economic advantages should be taken into consideration when evaluating a lease as a potential candidate for Lease Automatic Custody Transfer.