LACT and the Pipeline

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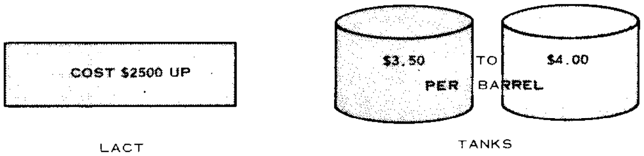
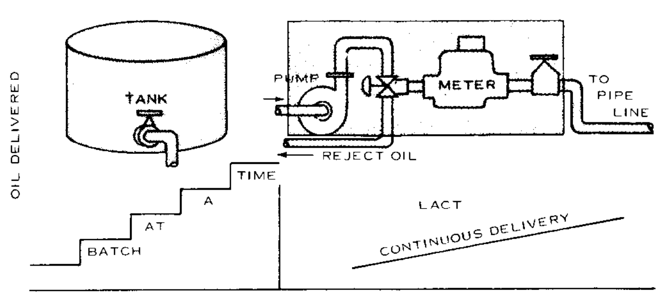
What does the pipeline expect from LACT? Basically, we expect only one function: accurate and dependable measurement of both quantity and quality of crude oil to be transferred from producer to pipeline. This represents no change from conventional gathering where the pipeline company strapped a producer owned tank, prepared a table showing its content at various oil heights, and ran oil after gauging and obtaining temperature and samples for completing the quantity-quality determination.

Why then have basic performance requirements and the matter of ownership become so clouded? Complexities arise from two sources. One is that measurement of oil has changed in concept from a "batch at a time", as in tanks, to one approaching continuous operation. The second is the degree of automation designed into the LACT to satisfy the functions required by the owners' operations. The second is independent of the basic function that the pipeline expects of LACT -- that of measurement,



LACT REPLACES TANKS IN CAPITAL INVESTMENT.

Pipeline position on producer ownership of LACT is based on past practice in which producer historically has furnished the measuring vessel. A meter or dump tank is the LACT substitute for this vessel. Changing the concept of crude runs from a "batch at a time" to one approaching continuous operation merely imposes the additional requirements of proportional sampling, and continuous BS&W monitoring for quality determination. Essentially, the pipeline position is just that simple.



CHANGE FROM CONVENTIONAL GAUGING TO CONTINUOUS DELIVERY MAKES CONTINUOUS SAMPLING, TEMPERATURE CORRECTION AND BS&W MONITORING NECESSARY

MEASUREMENT THROUGH METERS

The LACT facility must be capable of accuracy at least equal to conventional measurement. Total design must consider limitations of individual component performance to uphold this accuracy standard. For instance, a meter will not measure the same volume when it runs fast as it does running slow. Hence, a reasonably constant volume pump becomes necessary, such as a rotary (gear type) or a centrifugal pump operating against a fixed head as imposed by a back pressure valve. Also, a device safeguarding this flow rate comes into being to shut down the LACT unit should the rate deviate significantly from normal. Here the normal rate would be that at which the meter is proved but also should be between its accuracy limits of 20% to 80% of its rated capacity. The easy way to make this shutdown device function is to tie delay relays into a meter actuated pulsing contact. The relays can then bracket the measurement rate and provide a shutdown upon significant deviation from this norm.

The normal rate is a variable which can be established by agreement between producer and pipeline to satisfy both operations. The important thing is that, once this rate is established and the meter is proved, it should be operated at this rate during the metering period. This can be continuous or intermittant, depending upon the production of oil.

As the meter operates it will wear, and slippage through it will change. This change will alter the meter factor so that seldom do we obtain the same factor on succeeding monthly provings. Experience has shown that a deviation of 0.25% from the preceding month indicates a need to repair the meter, unless there is a change in operating condition or product properties, such as viscosity, that would explain the drift. A cheaply built meter not designed to operate in the medium of "dirty fluids" will cause excessive repair with accompanying excessive costs. We have urged all LACT owners not to compromise on meter quality for crude oil service. Small additional investment for a quality meter pays big dividends in reduced maintenance.

AFFECTS OF TEMPERATURE CHANGE

Temperature correction has been fairly well solved by compensators on the meters. However, there is still considerable source of error in the measurement due to wide variations in temperature experienced when oil can be run either from a cool sales tank or from a hot heater treater line. In some instances the oil in the sales tank becomes quite warm in contrast to the temperature assumed while the tank is idle. This temperature difference causes temperature compensators to operate over wide ranges. Corrections are not always linear, and some error in compensation results in this wide fluctuation.

Another problem in connection with the compensators arises when they are required to operate at their upper limit, with the result that there is an opportunity for the compensator to become ironbound or out of its near linear range of compensation. This lack of linearity and ironbuilding can occur at the other extreme for oil which has been allowed to cool in frigid weather. Normal range of temperature compensations run from 0 to 150 F or 20 to 120 F, depending on makes of meters employed; but it is highly desirable to get a compensator which generally will operate close to the mid ranges for all oil being measured.

We are aware of wide variations of viscosity in crude oil due to temperature changes. These variations are caused, as mentioned before, by intermittant operation and the requirement of the crude to be processed through a heater treater before it becomes merchantable. This viscosity change affects the meter factor and, to date, there have been no PD meters designed to measure oil accurately through this viscosity change. The subject of temperature variation is directly linked with the correction for volume that the meter supplies to correct the volume measured to 60 F. This correction must go through a calibrator section of the meter which can be furnished either by group, as broken out in Table 7 of the "ASTM Petroleum Measurement Tables", or by gravity, if Table 6 is the standard of correction. Some pipeline companies will use one table and some another, and the type of calibrator furnished with the meter should be chosen to correspond with the measurement parameters adopted by agreement between producer and pipeline. Our company, for instance, uses Table 6 for volume correction and would recommend a calibrator be furnished which corresponds not to the group but to the particular gravity of oil to be measured through that LACT unit. When this problem is ignored, it is possible at the extremes to have a miscorrection of volume equal to accepted tolerances of meter measurement.

We have in recent years requested throughout a given system that meter registers be furnished without ticket printing mechanism. This is not so rigidly enforced in gathering areas as in major trunk line delivery points where it is possible, because of five digit printing, to lose quantities of oil in even 100,000 bbl. increments. Because of this our tickets nearly always will be made by reading the non-resettable counter of the meter register rather than the ticket printing devices. This policy is a money saver by not having to buy the printing head.

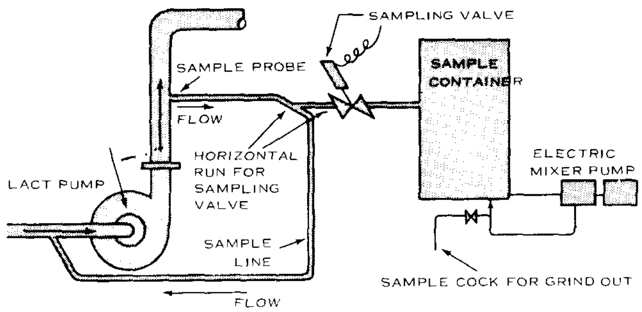
SAMPLING

Sampling of a continuous process needs to be proportional to flow, and most of the samplers presently employed are of this type. Since a pulser from the meter has generally been installed for rate control, it is reasonable to use the same signal to actuate a sampling device. This makes the sample proportional to flow through the meter, and total quantity can easily be adjusted by limiting a valve travel or by providing flow through a fixed orifice for constant time and pressure conditions. Some LACT units are justified partially on gravity improvement, and proper sample treatment becomes very important. The sample should be collected in a pressure container which will not permit vapor loss and should have power mixing before being withdrawn to insure homogeneity.

IMPORTANCE OF GOOD SAMPLING TECHNIQUE

In general, we feel that there is some room for improvement in sampling. This applies to equipment design to some measure, but also applies to the technique employed in sample treatment as it is taken from the sampler and analyzed for its gravity and BS&W. Since the sample in the container is a small portion of the total oil run during the metering period and since the part of that sample analyzed for BS&W is small in comparison with that accumulated in the sampler, a technique assuring the continuity of representation must be employed without the compromise sometimes resulting from familiarity. In this phase of quality determination, it is possible to arrive at errors far exceeding the meter accuracy standards accepted by the industry. A sampler which does not take a representative sample because of lack of proper piping configuration, an absence of adequate mixing equipment for stirring the sample, or an improper grindout or reading of the centrifuge tube all can be responsible for a gross error. Producer and pipeline alike should be extremely interested in this sample determination.

The sampling tap should be located on a riser in the LACT skid and should be connected by the shortest possible line to the sampling valve and container. If this minimum length is difficult to design,



SAMPLE LINE CONNECTED TO RISER AND LEADING TO SAMPLING VALVE IN HORIZONTAL RUN BEFORE GOING BACK INTO PUMP SUCTION.

a small by-pass line from a riser on the discharge side of the pump around to the sampling valve and back to the pump suction will serve to keep dead sample oil to a minimum. In either event, the sampling valve should be so installed that BS&W will neither accumulate nor shed between sample pulses. A horizontal sampler valve connection satisfies this need.

API GRAVITY DETERIORATION OF OIL

Sampling has been discussed in some detail and in connection with gravity improvement. The gravity improvement itself should be examined somewhat if it is to be included in the economic studies justifying LACT. General design of facilities provide for a tank receiving raw oil which is sent direct to heater treaters. Chemicals are used in some, along with the heat, but some are heated to a rather high temperature (not exceeding 150 F) to minimize the amount of chemicals required. Many of these heater treaters do not have heat exchanger boots and the hot oil is run directly to the sales tank where some of the light ends can be vented to atmosphere. This results in gravity deterioration, as well as volume shrinkage. It is easy to see that a system operated with a minimum of people would be less troublesome if the oil is overheated to assure its meeting pipeline requirements of BS&W. However, this excess heat does have the effect of reducing chances of economic advantage in gravity improvement, should this be originally included in the economics.

A side effect of this overheating is that it results in additional paraffin precipitation on the side walls of the pipeline and makes it necessary for us to run scrapers more frequently. Some of the frequency requirements are learned painfully after the pipeline has nearly plugged up and the running of the scrapers complete the job. This phase of LACT has added to the expense of pipeline operation rather than próviding economic benefits.

THE BS&W MONITOR

A pump, a sampler, and meter provide the necessary elements of LACT for both quantity and quality determination. However, because oil acceptability of 1% to 2% BS&W, depending on the pipeline, cannot be determined in advance, an oil rejection monitor has been made part of the LACT skid. This is a capacitance type instrument which determines a deviation from the normal dielectric constant of the crude caused by water and/or solids. The capacitance probe is calibrated to a BS&W grind out for a specific crude and is designed to supply a relay contact closure upon detecting a crude containing more than a present allowable. Reaction on a LACT skid is to tolerate the surplus for 30 to 45 seconds, and if oil still registers bad then a three-way diverting valve is closed against oil going to the meter and opened to a bad oil tank for retreatment. At the same time, the circuit shutting down the LACT skid under rate conditions different from normal is by-passed so that the pump can continue to run the high BS&W crude out of the sales tank back for treatment. When good oil again is encountered, a time delay of 30 to 45 seconds generally will divert the stream back through the meter and out of the bad oil tank.

If there is a pipeline pump on the discharge of the LACT unit, this unit, being mercoid operated, shuts down because of no oil and restarts upon resumption of good oil. It is easily seen that repetitive starts and stops occurring within a short period of time will result in a burned out motor. Therefore, it sometimes is required to lengthen the time delay up to 15 minutes before rejected oil can again be turned back to the pipeline.

PROVING OF METERS

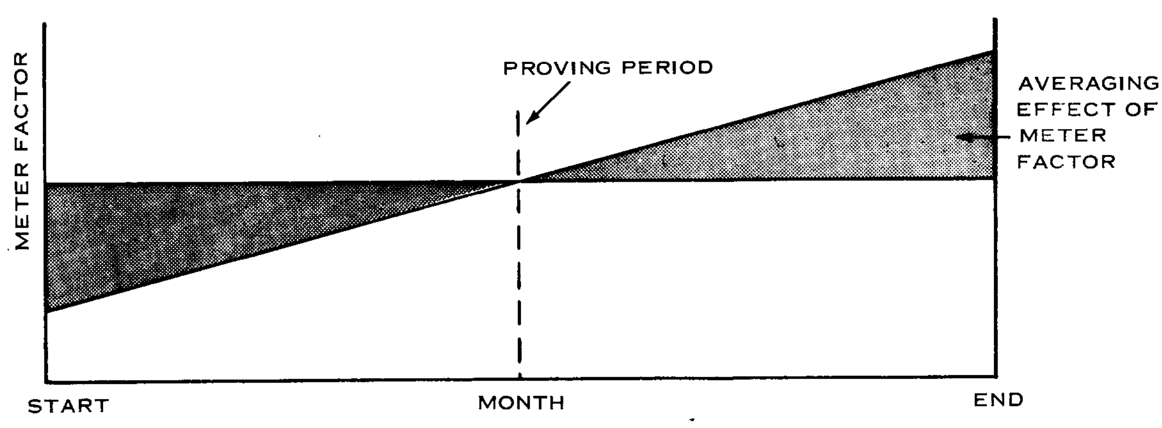
Proving of LACT meters generally occurs monthly. A deviation from this would be based on the experience derived from the particular meter involved and in the particular service in which it is used. The amount of throughput during the metering period, the type of crude oil measured, whether extremely dirty or corrosive, the quality of the meter, all have an effect on the metering period between provings. It may be desirable to extend this proving period to a longer period if such can be justified by a good experience with that installation. Shorter proving periods could become necessary where repeated maintenance is required to make the provings fall within accepted tolerances.

Proving can be accomplished by using a prover tank, a master meter, or stationary or portable pipe provers. Our company in West Texas has thus far not adopted master meter proving because of compromises in measurement accuracy that can occur. Our provings are taken as close to the middle of the month as is practical and the factor thus obtained is applied to all oil run during that month. This eliminates the necessity of "factor averaging" and simplifies ticket preparation and oil accounting procedures. If the meter does not prove, the "ticket" is written for the oil delivered since the first of the month using the last reliable factor. Some use an average of the factors obtained in the proving attempt.

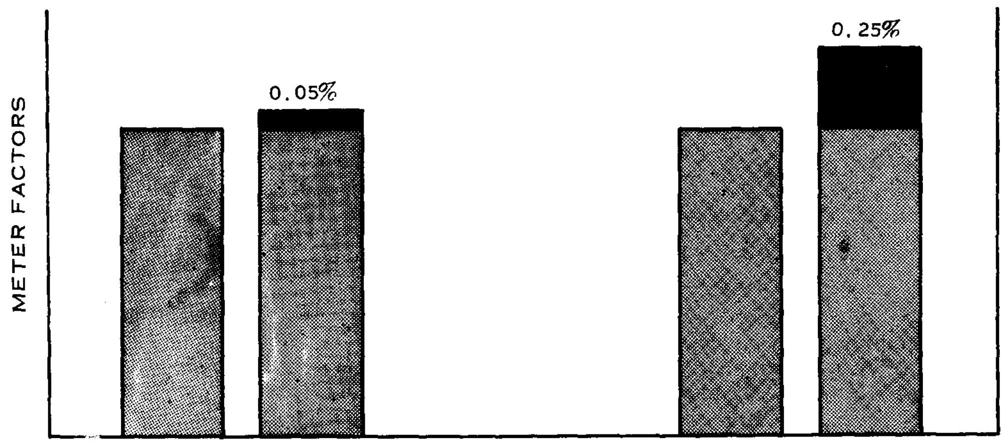
What are the tolerances of meter proving? These generally have been established industry wide at two runs within 0.05% of each other. The 0.05 per cent is the approximate tolerance in gauging a 10,000 bbl tank to the closest 1/8 in. An average between these 2 provings gives a factor 0.025% accurate under the conditions at time of proving.

SEALING OF LACT FACILITIES

The pipeline sealing of meters, monitors, samplers, set stop counters, etc., sometimes appears odd since such seals prohibit access of the owner to his own facilities. However, regardless of ownership, such seals would be necessary in order to eliminate tampering and to satisfy both producer and pipeliner of unaltered measurement. Of equal importance is that such sealing is required by regulatory bodies in



METER FACTOR OBTAINED AT MIDDLE OF MONTH APPLIES TO ALL OIL DELIVERED DURING MONTH.



producing only the allowables and in assuring royalty owners of their fair share of production.

LACT DEPENDENT ON SKILLED OPERATORS

The pipeline recognizes that the success of LACT is based upon its proper operation and maintenance in the fields. These are supervised by personnel of both producer and pipeline; and their understanding, attitude, and skills directly affect the success both in economics and measurement of oil by LACT. There are many facets of success in LACT that can not be written into operation and maintenance manuals, but rather must be sensed by experienced, alert and objective operators. Skills such as detection of air, leaky valves, ability to determine specific gravity, flow rate, meter readings, temperature readings, play a large part in determining the success of the installation.

PIPELINE PARTICIPATION IN LACT

Economic incentive has been responsible for LACT's development and phenomenal growth. Producers have saved significantly in both capital investment and operating expenses. Pipelines have been able to reduce operating expenses too. The question arises that if the pipeline saves money, why don't they participate in the initial LACT cost? Many pipelines do. Our company has invested in all of the recent installations by purchasing and calibrating the proving means. This has been prover tanks, as well as portable pipe provers. Further, we have taken the initiative in meter provings and many times go so far as to clean meter calibrators, if such is indicated through meter proving disagreements. Our capital investment and operating expense on the average represents our proportionate share of LACT and is justified by savings in reduced gauging costs. However, there is seldom any benefit to the pipeline in reduced costs realized by the installation of a single LACT unit.

LACT development has certainly made it possible for pipelines to hold down their gathering tariffs in the face of increased labor and material costs. This is a benefit to the industry and public, but usually the producer has no interest in tariffs since the buyer/shipper pays them.