A Pipeliner's Look At LACT

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INTRODUCTION

The use of the PD meter as a measuring tool in gathering and trunk pipe line operations has increased during the past few years to the extent that it is now almost universally accepted, and rarely is any reluctance indicated when custody measurement by PD meter is suggested. Meters provide more accurate measurement with less manpower and furthermore, they lend themselves to the ultimate in automation. In the Midland Area of Humble Pipe Line Company the future of meters and metering could only be described as "quite optimistic."

The purpose of this paper is to present some of the facts regarding the present day use and application of meters and samplers and to discuss certain details regarding their installation and calibration which will influence the quality of measurement which the meter and sampler will provide, and to discuss the importance of accuracy.

GROWTH OF THE USE OF METERS

From Fig. 1 it will be noted that Midland Area operations now include the use of 169 PD custody transfer meters. In addition, there are 19 PD meters used for routine checking purposes.

PD Meters - Custody Measurement

October 1963

District	Number LACT Units	Number ACT Units	Total Custody Meters
Abilene	45	18	73
Andrews	35	2	43
Big Lake	3	4	11
Caprock	34	4	42
TOTAL	117	28	169

Fig. 1 - PD Meters in Custody Measurement, Midland Area.

Fig. 2 is a recap of LACT operations during October 1963. This growth has all taken place since 1958 and the trend is, along with the various unitizations, to the use of more and more LACT operations. In fields where producers have several leases, the trend is to bring all leases to a central location and use one PD meter with remote counters for the various leases, thereby reducing the cost by having only one PD meter unit. This will effect a very substantial reduction in operation cost to both the producer and the pipe line company.

METER INSTALLATION

During the course of operations with all of the meters previously referred to, we have gained a vast

October 1963

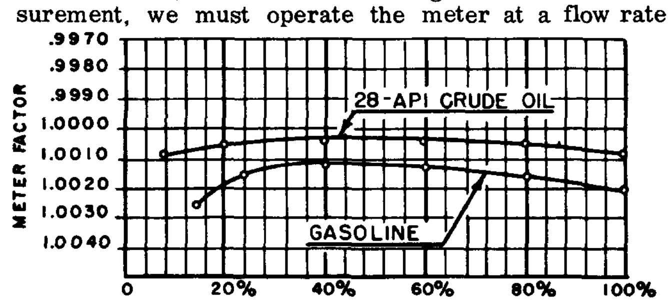
Total LACT Units in Operation	117
Total Bbls. Gathered - B/Day	185,879
Total Bbls. Gathered by LACT - B/Day	75,686
Per Cent Gathered by LACT	40.7%

Fig. 2. - Midland Area Gathering Operations

amount of experience. We now attempt to consider the matter of metering from the standpoint of how it may be further improved. It is not our purpose at this time to go into the details of how to install PD meters. In considering the design of a meter installation, the designer's first thought is usually the minimum investment required to make the installation. Frequently the desire to hold down the initial investment will kick back later and cause difficulty and inaccuracies which, in the long run, will affect the operating costs very adversely. For example, meter size is directly reflected by meter cost. However, meter size certainly enters into our problem as far as the future quality of measurement and operating cost is concerned. The designer will invariably try to size the meters on the basis of their maximum factory recommended capacity. It is our feeling that to secure good, uniform meter measurement and low operating cost, PD meters generally should not be operated continuously at rates above about 60 to 75% of their rated capacity. At such flow rates, the meter will have a much greater life and will, in the end, provide more accurate measurement at less cost. Likewise, at such flow rates, the measurement accuracy will be substantially improved.

METER ACCURACY

In connection with what has just been said about meter accuracy, Fig. 3 presents a typical meter performance curve from which it may be noted that the so-called "flat" portion of the curve represents approximately 60% of the curve. At extremely high or low flow rates, the tendency is for the accuracy curve to fall off; therefore, in order to secure good accurate measurement, we must operate the meter at a flow rate



TYPICAL METER PERFORMANCE CURVE

Fig. 3

which is on the stable portion of the curve. Accuracy curves presented by the various manufacturers are most generally based upon a light oil such as a solvent or kerosene, and it should be recognized that when the meter is operated with a heavier fluid, the resultant curve might vary considerably from the manufacturer's curve. For this reason we must know the performance characteristics of the individual meter at its installed location, operating on its normal liquids, and at its normal flow rates.

As the meter continues its operation, it is extremely important that a record be maintained showing the performance of this meter continuously. A convenient and helpful record of performance is a graph with meter factor plotted vs. time (or through-put).

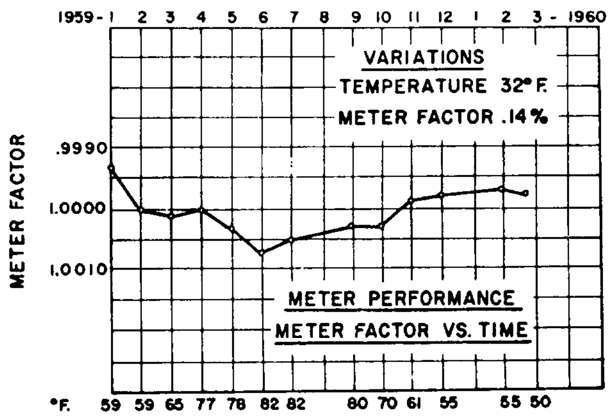


Fig. 4

Such a curve is illustrated in Fig. 4 which is an actual record of a meter's performance over fifteen months during which time the maximum temperature difference was 32° F. and the extreme meter factor variation was only 0.14%. It may be noted at the bottom of this graph that the flowing stream temperature is also indicated corresponding to each meter calibration. Meter factor variation may occur for a number of reasons, some of which are normal and to be expected. A type of this seasonal sine-wave variation may also be observed under summer and winter conditions in which a noticeable difference occurs.

It should not be overlooked that the meter factor is a representation of such diverse influences as fluid

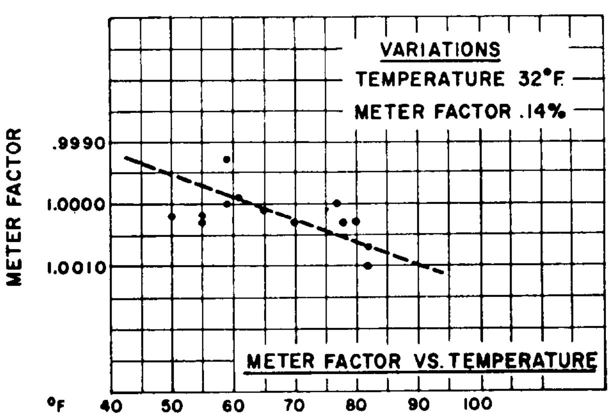


Fig. 5

slippage (which is a function of viscosity and meter operating clearances), hydraulic losses, friction, torque loading, film, and lubricity of the measured fluid.

Perhaps changes in viscosity are too often ignored and it should be realized that each grade of crude has its own characteristics. In the case of a low V-I crude, for example, the meter factor should be determined more frequently than in the case of a high V-I crude.

Therefore, in learning the characteristics of the crude to be encountered, viscosity index is an important factor since it is related to the frequency of meter proving. This is illustrated in Fig. 5 which is a plot of meter factor vs. temperature. The dotted line deviates considerably from unity and as the viscosity increases, the steeper will be this deviation, which means that with low V-I crudes, changes in the flowing stream temperature may be the best criterion by which the frequency of proving is determined.

We mention all of this about accuracy because we are becoming more and more conscious of the economic importance of measurement inaccuracies. For example, at one location where the volume of oil received is in the range of 300,000 bbl. per month, a long measurement of 0.1% would amount to a loss of $1,000 per month. Obviously a loss of 0.01% would amount to approximately $100 per month. Such figures add up to real monetary importance and perhaps our first question should be, "What is our measurement tolerance?" Back in the old days we perhaps would feel satisfied with an overall measurement accuracy of 0.25%, but in present day operations we certainly strive to hold our measurement accuracy below 0.1%. Sights are set more in the range of ±0.01% or 0.02%, which present day experience indicates we can attain.

METER OPERATION AND PROVING

Now that we have adopted the meter as a prime measurement tool, procedures used in its operation must be given careful and complete consideration if we are to get out of it the qualities which are built into it. In the operation of PD meters there is perhaps no question that the matter of meter proving is of more significance than any other phase of operation. Normally we think of a meter as registering approximately the actual quantity of liquid passing through the meter, but we know the performance of the meter varies due to a number of causes and we therefore establish a factor which must be applied to the metered quantity to adjust it to the true quantity passing through the meter. A regular schedule of meter proving is vitally important because it establishes that the previous measurement has been correct, or that the meter has not deviated beyond the allowable tolerance since the previous proving. In addition, it determines if the meter mechanism is functioning correctly and it establishes its current meter factor.

We may think of temperature variation as being an important or sole need for proving. This is but partly true. It should be remembered that the temperature compensator is, in effect, a mechanical temperature integration device designed solely to adjust meter through-put to a 60° F. basis, which it does remarkably well. The meter factor, however, assigns a correction value to a number of other variables which are perhaps impossible to separate. For example:

1. Fluid slippage, which is a function of viscosity and meter part clearances.

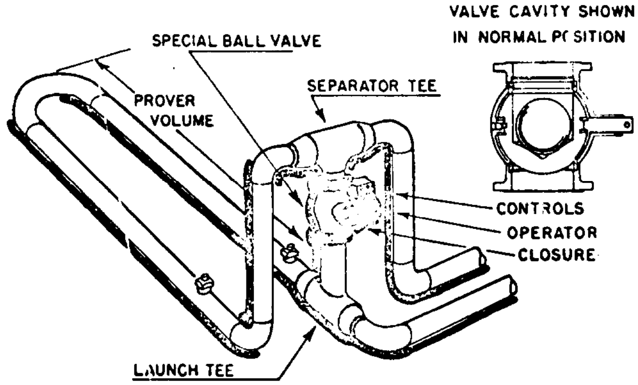
2. Friction load on internal meter operating parts.
3. Torque loads imposed by extra equipment; such as controls, ticket printers, compensators, combinators and pulse generating equipment.
4. Carry-over or film adherance to the walls of the meter mechanisms, significant in heavy oils, particularly in cold weather.
5. Variation in internal hydraulic losses and/or rate of the flowing stream.
6. Lubricity of the liquid, which is sometimes greatly influenced by variation in basic sediment and water content.

All of these conditions are subject to considerable variation and consideration of these variables must enter into the question of frequency of proving.

We have talked about some rather insignificant measurement errors as far as numbers are concerned, but when they are converted to dollars their significance becomes much greater. Therefore, in planning the operation of a meter setting, proving frequency should be considered in its relation to sustained accuracy rather than to, "What does it cost to prove the meter on a frequent, rather than an infrequent, schedule?"

Proving methods have recently been improved to the extent that meter factors may not be determined quickly, and the procedures have been so simplified that a specialist is not necessarily required to do the job.

Most of the improved technique has been brought about by the development of proving procedures referred to as "Running Provings" or "High Speed Proving." In these procedures the meter is proved under its normal operating condition, with no interruption whatever such as due to starting and stopping of the meter at the beginning and ending of the proving. Temperature changes during the proving are minimized, provided the prover is adequately insulated.



SPHEROID TYPE PROVER

Fig. 7

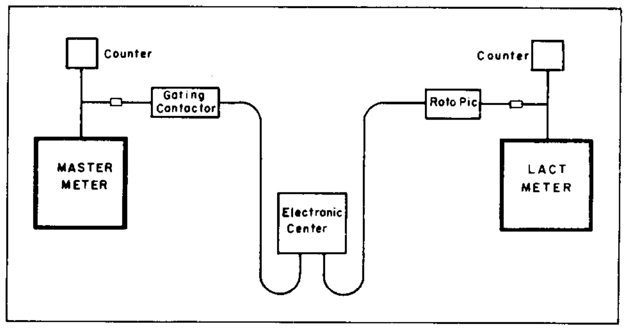
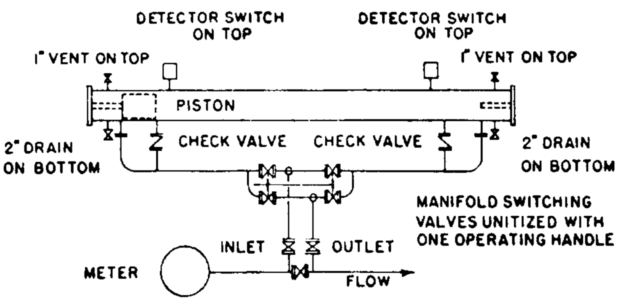


Fig. 8



PISTON TYPE PROVER

Fig. 6

There are two well known methods of doing this type of proving; namely, the bi-directional and the uni-directional methods, illustrated in Figs. 6 and 7. Both of these methods involve a displacement of a known volume of liquid contained in a section of pipe, between two detection switches, which are actuated as a mechanical displacer passes by the switches. Articles in the trade journals have described these methods; therefore, it is not our purpose to discuss their details at this time.

Fig. 8 illustrates an entirely new method of proving; namely, a previously proved Master Meter, as the known volume. To the Master Meter is attached an "electronic gating device" which gates an "electronic counter" on and off, which in turn is connected to the meter to be proved. Both the Master Meter and the line meter are in continuous operation, the same as piston proving. The advantages of this type of proving are as follows:

1. Larger proving volumes, 12 bbl. as compared to 2 bbl. in the portable piston provers.
2. Higher resolution.
3. Lower costs, as this proving equipment only adds \$1300 cost to the Master Meters, whereas a portable piston prover will cost approximately \$6500.

SAMPLING

During the last few years technology has advanced to provide increased accuracy in all phases of measurement except sampling. Sampling, in many cases, has been considered a menial task and assigned to persons who performed the work as a routine operation according to instructions without being aware of the problems that cause inaccurate results. As automation advanced, the advantages of automatic samplers became more apparent; however, there was still considerable question concerning the accuracy of sampling. It was thought that automatic samplers were the cause of these inaccuracies and, as a result, everyone seemed to be in the act of building a universal sampler that would solve all of the problems. A lot of samplers were built. However they all operated on the same principle; they accumulated a sample by removing small segments of the stream at pre-set intervals. If the stream were uniformly mixed at the time each segment was removed, then conditions were proper for collecting representative samples. If the stream were not uniformly mixed, then the sample collected was most likely not representative no matter what kind of sampler was used.

Sample lines should be as short and as small as practical without causing clogging. As automatic sampling in most cases is an intermittent operation, the flow in the sample line is also intermittent. Under such conditions any water in the sample line may drop out and slip back into the main stream if the line is not properly slanted. Sample lines should be slanted so that flow by gravity will be in the direction of the sampler and storage container. Configurations in sample lines that might trap water should be avoided.

Small sample lines are desirable because they increase the velocity of the sample stream. The ratio of the volume of a sample line to the total volume of sample should be as small as practical, so that any sample remaining in the sample line at the end of the test would have negligible effect on the final result.

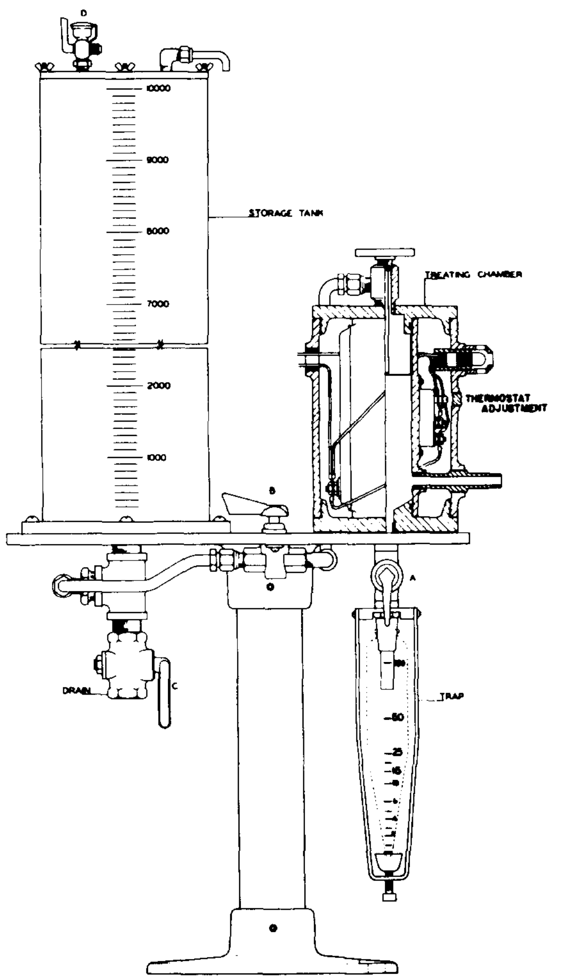


Fig. 9

Fig. 9 illustrates a new concept in determining BS&W content. Actually, it goes back to the old days when the settling method was used to determine BS&W content. This device replaces the sample container connecting into the sample head. As the meter pulses, the sample head releases a small segment into the treating container which has a constant temperature of 140° F. In the top portion of the treater there is a Teflon filter which holds back the heavier parts, or BS&W, letting it fall into a test tube. The test tube is filled with a solvent through which the BS&W passes, allowing a clear line of demarcation for reading. The good oil container is calibrated and graduated up to 10,000 cc. To determine the percentage of BS&W, divide the number of cc. of good oil into the number of cc. of BS&W in the test tube and calculate to the hundredth of a per cent.

GREEN OIL

Before LACT it was a traditional practice throughout pipe line gathering operations to enforce a 24 hr. weathering time in lease tankage before oil was gauged and turned to the pipe line. This was done to allow the oil to settle to a liquid state with no entrained gases. It is true that these entrained gases did vent to the atmosphere; however, it must be noted that the pipe line companies transport liquids only. So any gas that escapes from oil is a direct loss to the pipe line companies. As an example: When "green oil" from a lease is taken into the pipe line system the light vapors, or gases, will vent themselves to atmosphere at the first tankage, thereby causing a direct loss to the pipe line companies.

The problem has become quite serious due to the increasing number of LACT's being installed. How serious is this problem to the pipe line companies? We in the Midland Area of Humble Pipe Line Company have made numerous tests on LACT units, using stabilized or weathered oil vs. "green oil" for proving, and find our losses from "green oil" to range from 0.03% to 0.20%. This variation is due to the following:

1. Size of the surge tank.
2. Rate of production into the surge tank.
3. Adequacy of the heater-treater unit.
4. Temperature of the production into the surge tank.
5. Positioning of the high and low liquid leveling controls.

What is the solution to this problem?

We, as the pipe line, are requesting the LACT operators to set aside enough oil for proving 24 hr. before we prove their meter. We find this does not cause any great problem to the operator, because on most LACT leases there is sufficient down time to allow for weathering the oil to be used in proving the LACT.

The producer's solution to his question, "What happens to the escaping vapors or gases?" is to install a "vapor recovery unit" and sell these light ends to the gas plant. In most cases we know that his rate of return will be considerably more than if these light ends passed through the PD meter to the pipe line and subsequently became an unaccountable loss to the pipe line.

It must be remembered that the pipe line companies do not purchase any oil from the producers, but act only as agent for the purchaser, so it is necessary that the pipe line deliver to the purchaser the same amount of oil that was received from the leases.

SUMMARY

In summary, it would appear that as far as Humble Pipe Line Company is concerned, the PD meter is here to stay. Other conclusions which we may consider are that regardless of how accurate the manufacturer has made the meter or how carefully the engineer has selected the right meter or sampler for the job, the final results will depend upon the operating procedures used in the field and upon the personnel who are directly responsible. Successful metering demands a carefully coordinated and controlled program, including an efficiently organized system of supervision or properly trained and qualified personnel. It is in these phases that the ultimate success of meters and samplers will lie.