LACT Will Work for You

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INTRODUCTION

What is LACT?

Lease Automatic Custody Transfer (LACT) is the name given to the systems which automatically perform the functions of measuring and recording of temperature compensated oil quantity; sampling for subsequent determination of quality; and the running of the oil from the lease into the pipeline in accordance with preset schedules on an unattended basis. Automatic monitoring of oil quality with shut-in of unit on sensing of unmerchantable oil is used in conjuntion with LACT.

There are two basic types of LACT metering in use in the industry today. These units are (A) positive volume dump meters and (B) positive displacement meters. Each of these units is designed to perform the functions described above but each utilizes different methods. A third unit (C) is a special adaption of (A) for use on small volumes.

The flow diagram, Fig. 1, shows the flow of fluid for all systems.

PRINCIPLES OF OPERATION

A. Positive Volume Dump Meter LACT

The Positive Volume Dump Meter LACT unit measures the volume of fluid between the seat of a dump valve and a high level weir. It requires no recalibration or correction factors once the unit has been originally calibrated so long as foreign material does not accumulate within the metering volume. A positive high level is obtained by overfilling the weir and draining back to the weir height.

A pressure recorder continuously records the head in the meter tank giving a pictorial view of the operation for both an operational and accuracy check. The temperature is recorded for each dump to complete the record. The meter tank with its necessary valves and float switches, the electrical controller, and the head and temperature recorder make up the basic unit. A temperature compensated volume recorder-ticket printer and a BS&W monitor are added to the basic metering unit in order to give a temperature corrected, printed run ticket and to insure that only merchantable oil is run to the pipeline.

B. Positive Displacement LACT

Positive Displacement LACT units measure fluid by the revolutions of a meter. A fixed volume of fluid is trapped between two blades and is carried through the meter. Usually the fluid is pumped through the meter. These meters derive the name "Positive Displacement" from the principle of operation that a fixed volume is displaced from one side of the meter to the other and discharged. Each time one volume is displaced, the gear train to a counter is moved proportionally. The counter and printer reading are advanced or retarded by a temperature compensating mechanism to give temperature corrected volume. Various accessories, such as back pressure valves, deaerators, strainers, and monitoring, may be added to the basic unit to ensure proper operation.

C. Small Positive Volume Metering Units

The small positive volume metering units utilize the same principle as the larger positive volume units; a fixed volume of liquid is trapped between known points. In this case, the lower point is the fill and dump valve, and the upper point is the valve seats of the upper float pot and the vent. It is, however, a self-contained pneumatic unit. Similar accessories to those under "A" are often utilized.

OPERATION OF POSITIVE VOLUME DUMP METER

The positive volume dump unit illustrated measures

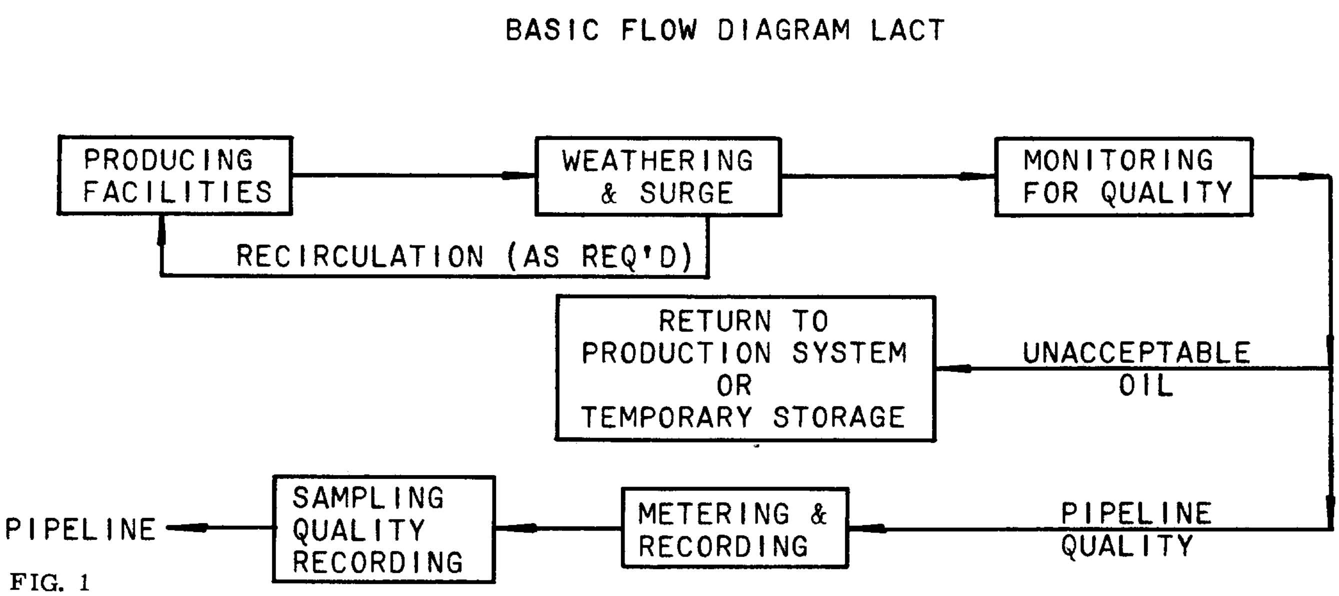


FIG. 1

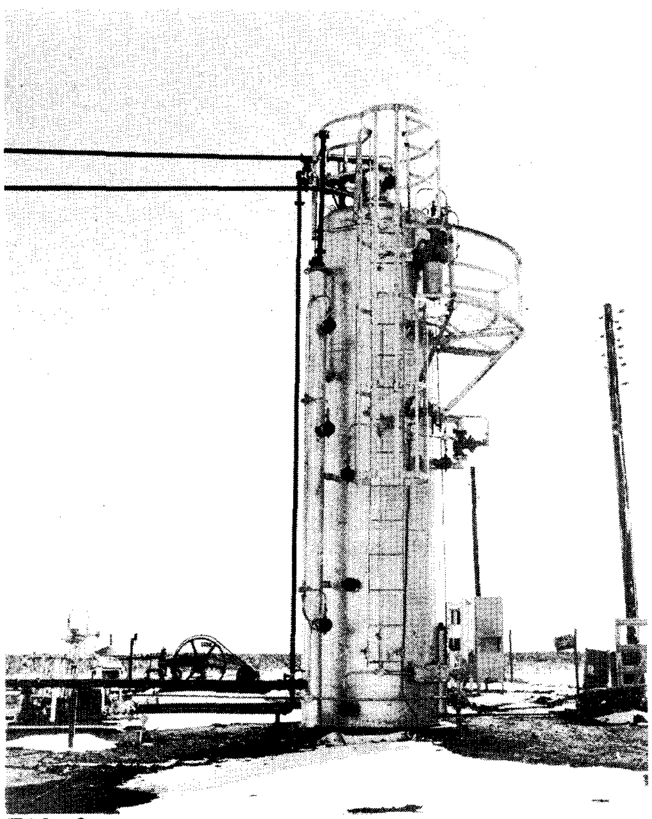


FIG. 2

a fixed volume of fluid between a weir and a valve seat. The metering section of the unit operates cyclic; however, the metered fluid is discharged into a sump tank which holds one and one-fourth times the volume of the meter. This enables the unit to operate continuously.

All valves are pneumatically operated but controlled electrically by solenoid pilot valves. The control panel consists of timers and appropriate relays to allow sequential operation of controls. Interlocks are provided between fill and dump valves, between level controls on the surge tank and the meter inlet, and also between the pipeline pump and the level in the sump tank. The control panel sends electrical signals to the proper solenoid pilots which in turn send pneumatic power to a valve to perform the function required.

Fluid enters the meter from the surge tank through a fill pump or through an inlet valve if gravity fill. The pump or valve is interlocked with level controls in the surge tank to ensure proper operation. The high level in the surge tank may operate an inlet valve to the surge tank, a lease shut-in valve, or other equipment as required for the individual lease. Its function may be described as "controlling surge tank inlet." The low level control in the surge tank ensures sufficient fluid to fill the meter without interruption due to loss of head. Other controls may be added for intermediate interlocks.

The pump will start or the valve will open provided there is proper level in the surge tank and provided there is a signal from the control panel. Fluid enters the meter section and rises until the upper weir has been overflowed and the upper float in the weir section has been actuated. Excess oil in the weir chamber overflows back to the surge tank through the vent line. The weir drain valve holds a positive level on the weir. In gravity fill units the excess oil remains in the vent line until the weir is drained.

Actuation of the upper weir float causes the pump to stop or the inlet valve to close and starts a timer in the controller. The timer runs for a fixed portion of time. This time allows any gas bubbles, entrained in the oil, to break out. At the conclusion of the settling time, the weir drain valve opens and drains excess oil from above the weir until the lower float in the weir chamber is uncovered. This oil drains back to the surge tank or into an overflow pot.

The drain valve then opens allowing the meter tank to drain into the sump section through a level detection section. The function of the level detector is to sense

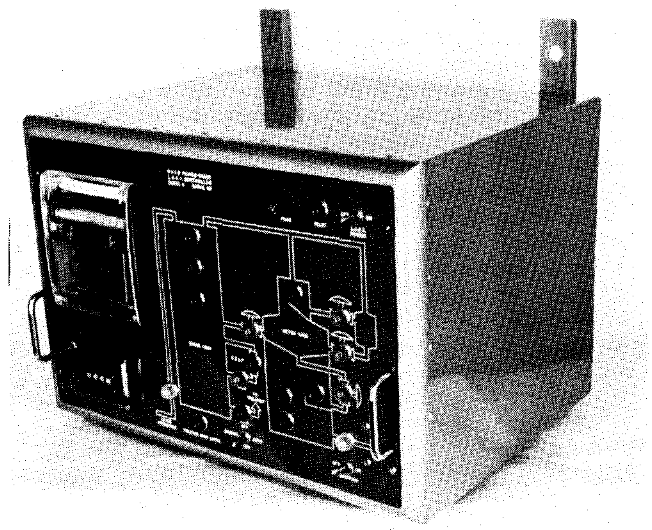


FIG. 3

that the fluid in the meter has drained out past the discharge valve. This level detector does not directly close the drain valve but instead starts a time delay to allow any oil which would cling to the walls of the vessel to drain out.

At the conclusion of the time delay, the drain valve closes. Fluid head and temperature of the oil in the meter are constantly measured and recorded on a chart

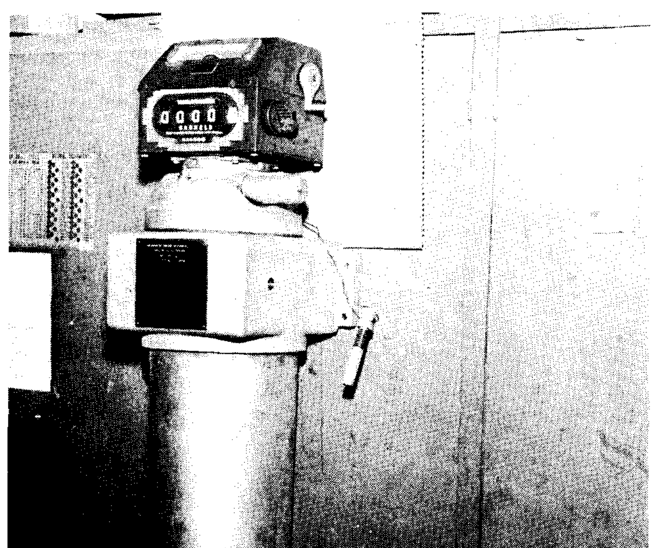
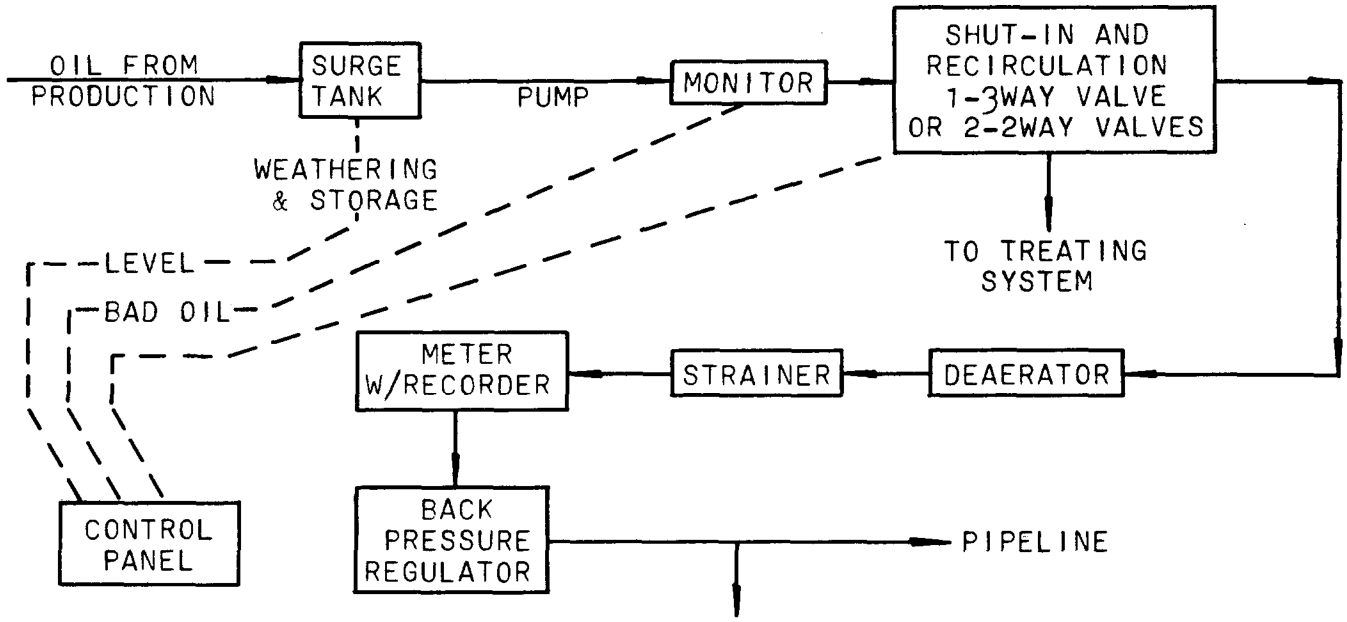


FIG. 4

FIG. 5

FLOW IN P D LACT UNIT



giving a pictorial record of the operation. On pump-fill units where the weir drains directly back to the surge tank, this completes a cycle and filling may begin again. On units where an overflow pot is utilized, this must be drained back into the meter before the next cycle. Draining of the pot is controlled by a timer.

In order to have a printed run ticket, it is necessary to have a temperature compensated counter. This is a device which has a rotational input proportional to the volume of each dump and is corrected for temperature by a mechanism which advances or retards the gearing. The counter is run during the weir settling and drain time.

OPERATION OF POSITIVE DISPLACEMENT METERING UNITS

As previously described, a PD meter operates due to the energy in the fluid flowing and rotates at a rate proportional to the volume flowing. Since positive displacement meters measure the volume of a closed system, it is imperative that the trapped volume be liquid only and not contain gas. This is ensured by maintaining a back pressure on the meter greater than the vapor pressure of the fluid being metered and by removing all entrained gas prior to the fluid entering the meter.

In order to operate, then, a PD metering unit must either have sufficient head in the surge tank to push liquid through the system or a pump is required. In either case, it is often advantageous to place a separator (usually called a deaerator) upstream of the meter to remove any entrained gas. Because a PD meter is a precise measuring device with close tolerances, it is recommended that the meter always be protected by a strainer. For best protection the strainer should be as close to the meter as possible. It is usually convenient to bolt the strainer directly to the meter inlet.

Due to the fact that the meter reading is affected by the clearance of moving parts and by the physical wearing of the parts, there are a wide variety of positive displacement meters manufactured for use in the industry. While each meter may have its own unique features, all meters are designed to perform the same basic function.

The following diagram illustrates a typical PD meter installation in custody transfer service.

Many variations are made from the basic flow shown above but these in no way affect the function of the unit. A common variation is the use of dual meters with various bypasses so that fluid may flow through both meters in series or through one or the other meter only. Quick connect prover connections are often added downstream of the meters for calibrating the meters.

Because these meters contain moving parts they must be calibrated initially for manufacturing variations, variations in operating conditions, viscosity of product metered, and for adjustment of automatic temperature compensation. After being placed in the service, they must be periodically adjusted for wear.

Meters are calibrated by running the fluid from the meter into a calibrated tank and comparing the meter reading with the temperature corrected tank volume.

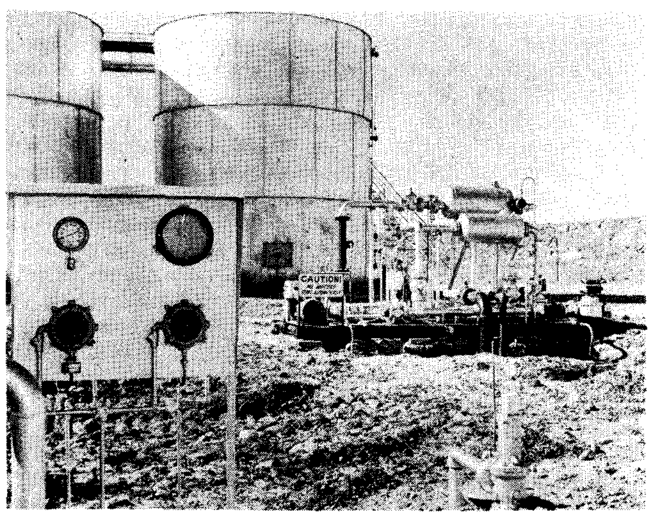


FIG. 6

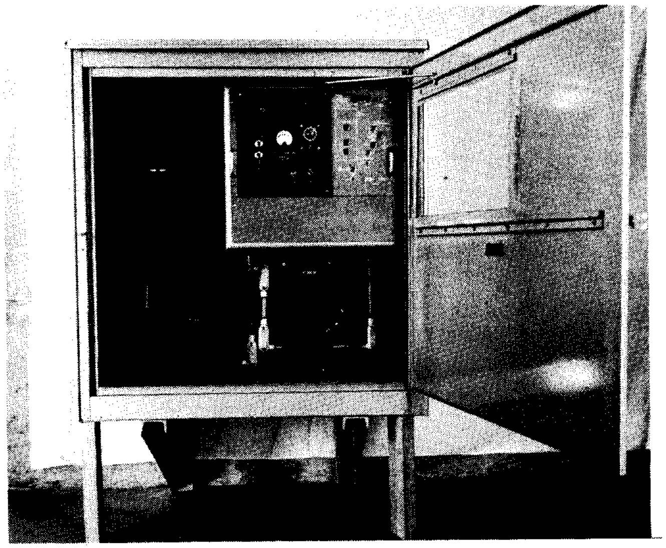


FIG. 7

Initially the calibration mechanism is set at the factory. Commonly a correction factor known as the "meter factor" is determined by calibration runs in the field. This factor is usually less than one. Meter factors are checked at intervals consistent with operator experience. Once the factor shows significant change, the meter should be replaced and repaired.

Fig. 6 shows a unit in the field incorporating almost all the features mentioned.

Fig. 7 shows a control panel for a PD unit. The control panel contains the BS&W monitor, relays to interlock float switches, motor starters and indicating lights showing operation. Run programming clocks as well as preset counters may be included as required.

OPERATION OF SMALL POSITIVE VOLUME METERS

The small meter as seen in Fig. 8 consists of a metering section and sump section for maintaining pipeline pump suction. It may be an entirely pneumatic unit, as shown, or can have electric operation if desired. The control panel for the pneumatic unit is mounted directly on the meter as shown in Fig. 9.

At the start of the fill cycle, the lines are open to the upper float chamber and the vent line is closed. The fill cycle stops when the upper float actuates, causing the valves to the chamber to close and the fill valve to go to the neutral position.

The switching pilot then diverts the fill and dump valve to the dump position and opens the vent valve. The upper float chamber remains full and closed. As the unit discharges, fluid flows through the lower float chamber. The first liquid raises the float, positioning the switching pilot for the end of the cycle. The float remains up until all the liquid in the meter has discharged. When the float drops, the fill and dump valve goes to the neutral position and the valves from the upper pot are opened. When the upper float drops, the fill and dump valve goes to the fill position and the vent valve is closed starting a new cycle.

Similar units are used in testing service; however, the sump is not required in these cases. As in other units for ACT service, monitoring and sampling is required. The monitor control is usually separate from the meter control.

The configuration shown in Fig. 8 and the operation described are for a particular unit. Other configurations and different control sequence are used but the basic operation is similar in all units of thie type: selfcontained control with pneumatic power between fixed points. This allows the repetition to be of the highest order.

APPLICATION AND LIMITATIONS OF UNITS

As stated at the outset, positive volume and positive displacement units both do a highly accurate and satisfactory metering job. There are, however, applications where each type of unit will operate to its best advantage.

A. Positive Volume Dump Meters

Positive volume dump meters, due to their mechanism of operation, are not affected by foreign materials in the crude, such as salt crystals, small paraffin particles, etc. In general, neither corrosion or erosion is much of a problem. The accuracy of the unit is independent of flow rate. From a maintenance standpoint, the only moving parts are diaphragm control valves. Since the differential pressure across the valves is low, the wear characteristics are very good.

These units range in size from meter body capacity of 25 barrels to 100 barrels. Due to physical size, the 100 barrel body reaches the upper limit of practical size.

On units of this size any error in operation can be quite costly. The control of these units, therefore, is a stepwise operation. Time delays are required to drain off overflows and to drain down the sides of the meter. Positive sequencing is mandatory and positive time delays are most desirable. Electrical sequencing is highly reliable while electrical time delays are inexpensive as well as reliable.

Temperature and head are recorded along with the dump count. Often a temperature compensated barrel counter is used. In additon, automatic sampling and BS&W monitoring are utilized. These accessories along with the control panel are roughly independent of the size and capacity of the meter and represent varying percentages of the total unit cost.

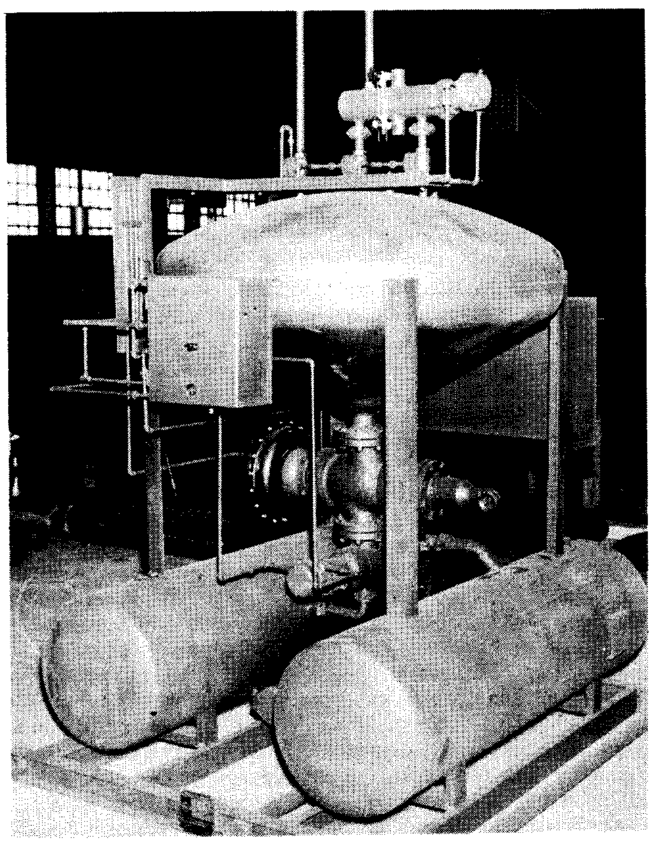


FIG. 8

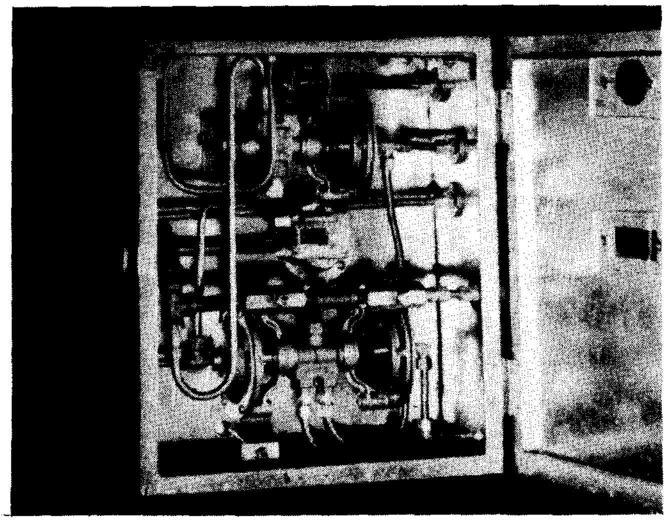


FIG. 9

It is common practice to coat the inner surface of the meter with plastic to give a slick surface. This has proved quite successful in inhibiting the formation of paraffin on the vessel walls. It also reduces the tendency of small quantities of liquid to adhere to the vessel walls.

Once a positive volume meter has been calibrated, it need not be recalibrated. These meters, however, should be inspected at intervals to be sure that neither paraffin nor foreign material has collected within the meter. These substances, of course, could change the metered volume.

B. Self-contained Dump Units

The small self-contained positive volume dump unit offers advantage under the same conditions as the larger units. The control circuit may be much simpler due to the physical size of the unit. The area of the vessel walls is small, eliminating the need for a positive drain overrun. There is little chance for gas entrainment; therefore, no need for upper weir settling time.

For these same reasons, the small unit cannot be scaled up to the large sizes and still maintain the reliability of operation.

The accessories required depend a great deal upon the individual field problem. Often a dump counter along with a temperature recorder will satisfy all requirements. In other instances, a head recorder and temperature compensated barrel counter are utilized.

These meters vary in size from 1 barrel to 10 barrels capacity with the smaller unit in predominance.

C. Widest Application

The positive displacement unit finds widest application where the flow rate is relative constant and the fluid is relatively free of solid contaminents. While typical accuracy curves as shown by the various manufacturers vary somewhat in appearance, it can be said that all PD meters operate to their best advantage between 15 per cent and 80 per cent of the rated capacity. The accuracy does not suffer to any great extent above 80 per cent but it falls off quite sharply below 15 per cent. This "fall-off" below 15 per cent is in favor of the buyer, not the seller. Meter wear characteristics are poor when operated at the full capacity.

Crudes with high paraffin content do not appear to offer any special difficulty to PD meters.

NEW DEVELOPMENTS

Improved meters of all types, giving higher accuracy and better mechanical performance, will continue to be developed. More trouble-free monitoring units will be developed.

Probably the weakest link in present LACT systems is the sampling techniques and equipment. There is no way at the present to prove or disprove various claims of sampling accuracy. In addition, it is necessary to collect and shakeout the sample which requires a manual operation in an otherwise automatic system.

Perhaps the biggest advance which should come to LACT will be the elimination of monitors or recorders and samplers, and the substitution of a controlling recorder or a controlling computer. This device will record BS&W or compute net clean oil so that sampling will not be required. Control functions will be performed so that unmerchantable oil cannot be sent to the pipeline. In a large field this data could be telemetered to a central point eliminating the need to visit the unit except for maintenance.