White Paper

LEASE AUTOMATION CUSTODY TRANSFER (LACT)

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EMERSON
Process Management

Introduction

This document covers Lease Automatic Custody Transfer (LACT) units installed on lease stock tank outlets which measure stabilized crude oil pumped into gathering pipelines or truck transport loading. Discussion is included around an operating company's work flow process to generate a measurement ticket and LACT unit operation.

LACT units are a necessary means to generate revenue from a production facility. LACT components, operation and Coriolis-specific instruction are provided by American Petroleum Institute (API) in the Manual of Petroleum Measurement Standards (MPMS). Emerson Process Management has several potential automation solutions which can automate as much or as little of the LACT operation and measurement ticket generation as an operating company desires.

Typical LACT Components

API MPMS Chapter 6.1 provides guidance on LACT unit components and operation. API MPMS Chapter 5.6 provides guidance on Coriolis flow meter installation and operation. Local regulatory bodies may have additional requirements. A typical area electrical classification is Class 1, Div. 2 as defined by the National Electrical Code and piping is often designed to meet ASME B31.4.

The major components of a typical LACT unit with a Coriolis meter are shown in Figure 1. Emerson Process Management partners with many companies which fabricate complete LACT units.

Major LACT components starting on the inlet side of Figure 1 will be detailed in the next few paragraphs. Flow through a LACT unit is generated by a charge pump. Centrifugal pumps which provide a smooth flow output are generally applied to these applications. Item number 1 is a sediment and water (S&W) monitor. A common S&W monitor technology measures the dielectric constant of the flowing fluid. These devices monitor the flowing fluid and determine whether the flowing crude oil is merchantable. Merchantable crude oil must have a S&W content below a certain percentage by volume (often less than 0.5%).

Items 2 and 3 include a static mixer, sample probe and solenoid valve for input to a composite sampler. A flow proportional composite sample is required in order to determine a batch average API Gravity (ρ_b) and S&W which is used to calculate Net Standard Volume. It is important to close the sample inlet when non-merchantable oil is being diverted and proportionally sample merchantable oil through the sales flowmeter. The sample container must be large enough to accommodate a flow proportional fluid sample during the run period. Automatic sampler guidance is provided in API MPMS Chapter 8.2.

A divert valve is located downstream of the sample probe. The divert valve has a fail safe position to route flow from the LACT inlet to the divert outlet. Divert outlet flow may be routed to a slop tank or a low pressure separator/heater treater on the lease for reprocessing. Once the S&W monitor determines that the flowing crude is merchantable, the divert valve switches to route flow through a downstream sales flow meter.

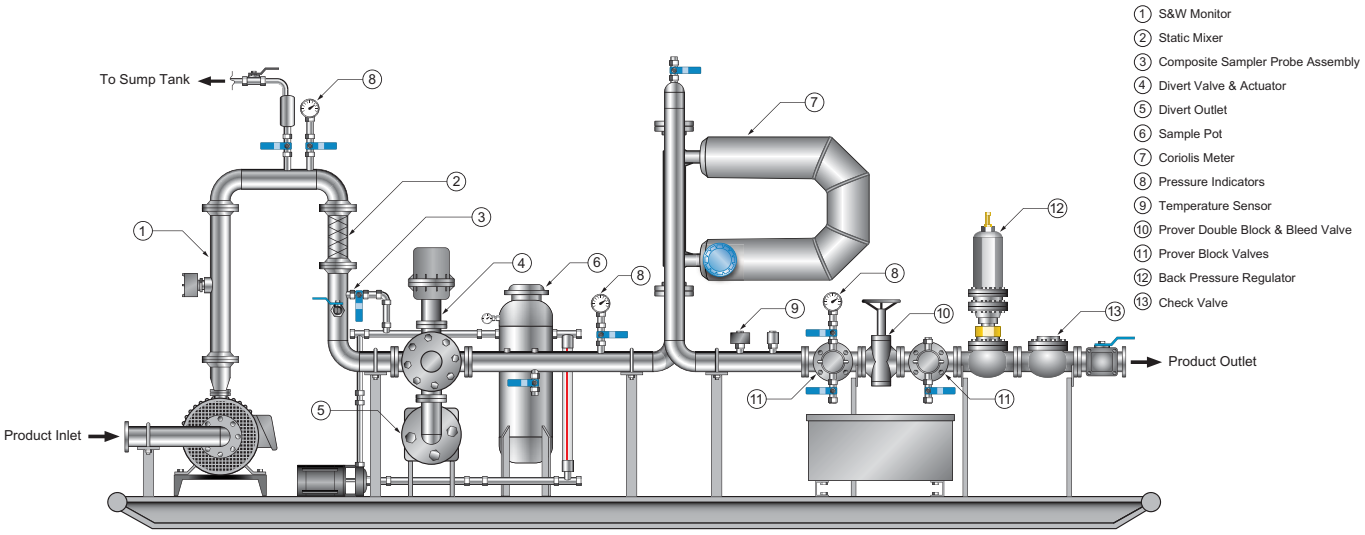

Figure 1. Typical Coriolis LACT skid design courtesy of Angus Measurement Services

The sales flowmeter is a Micro Motion® ELITE® Series Coriolis flowmeter installed in a flag (vertical) position with flow direction up through the sensor. A flow transmitter is used in conjunction with the flow sensor (Item 7). The flow transmitter produces gross volume pulses required for meter proving and provides a user interface to the meter. Fluid temperature and pressure measurements (Items 8 and 9) are directly downstream of the sales flowmeter.

Valves (Items 10 and 11) are provided downstream of the sales flowmeter to facilitate a portable meter prover. The in-line prover block valve is a double block and bleed valve which ensures that no valve leakage bypasses a prover. LACT sales flowmeters are typically proven on a monthly basis.

A back pressure control is installed downstream of the prover taps in order to keep the flowing fluid above its vapor pressure and a check valve prevents reverse flow through the LACT.

LACT Unit Operation

Lease stock tank level is measured and when it reaches a normal high level setting the LACT unit charge pump starts. S&W is monitored, and given a merchantable oil, the divert valve routes flow through the sales meter into a gathering pipeline. The batch composite sampler is enabled during the time while flow is passing through the sales flowmeter and a flow proportional sample is obtained.

When the lease stock tank level reaches a normal low level setting the charge pump stops running, the composite sampler is disabled and the divert valve switches to a fail safe position (divert).

In the case where no gathering pipeline exists, manual start and stop commands are used to control a LACT for pumping operations into a gathering truck trailer.

Programmable Logic Controllers PLCs and/or flow computers are used to automate LACT unit functionality.

Net Standard Volume (NSV) Calculations

NSV is the basis by which crude oil sales from a lease are measured. NSV calculations are standardized by API MPMS Chapter 12.2. LACT components provide the inputs to NSV calculations which yield a measurement ticket. *Net standard volume*, **NSV**, can be defined in the following way:

$$\mathbf{NSV = GSV \times CSW} \qquad (1)$$

Where:

NSV = gross standard volume adjusted for S&W.

GSV = total fluid measured at standard conditions, including both merchantable crude oil and non-merchantable components such as sediment and water. Volume at standard conditions indicates volume that is adjusted for temperature and pressure effects. Standard temperature is defined as 60°F in the United States, 20°C in Latin America and 15°C in the rest of the world; standard pressure is at 0 psig or 0 barg.

CSW = correction factor for S&W reducing the gross standard volume for non-merchantable content which is equivalent to the merchantable fraction of fluid.

The *gross standard volume*, **GSV**, is defined as:

$$\mathbf{GSV = IV \times CCF} \qquad (2)$$

Where:

IV = uncompensated indicated volume registered by a LACT flow meter.

CCF = combined correction factor.

When live temperature and pressure are available, the combined correction factor, **CCF**, is defined as:

$$\mathbf{CCF = MF \times CPL \times CTL} \qquad (3)$$

When only live temperature is available, a fixed operating pressure is assumed and the **CCF** is defined as:

$$\mathbf{CCF = CMF \times CTL} \qquad (4)$$

Where:

MF = meter factor that compensates an indicated volume for meter inaccuracy determined by meter proving. Often on LACT units, a *composite meter factor*, **CMF**, is used and a fixed operating pressure is assumed.

CTL = correction for temperature on liquid-density dependent factor to compensate for the temperature of the measured liquid.

CPL = correction for pressure on liquid-density dependent factor to compensate for the pressure of the measured liquid.

CTL/CPL calculations are based on API MPMS 11.1 using temperatures/pressure flow-weighted averages (**TWA/PWA**) and $\boldsymbol{\rho_b}$, density of oil at standard conditions.

The *correction sediment & water*, **CSW**, is defined as:

$$\mathbf{CSW = 1 - (S\&W\% / 100)} \qquad (5)$$

Where:

S&W% = percentage of sediment and water measured.

Typical Operating Company Work Flow Process

LACT units operate over a contract run period (often monthly or per truck load). At the end of the run period, a measurement ticket is generated using the NSV calculations outlined above. Several LACT unit inputs are required to generate the measurement ticket including reading the meter opening/closing sales meter volume, recording temperature flow-weighted average (TWA), and determining the average API Gravity ($\boldsymbol{\rho}_b$) and S&W content from the composite sample analysis. API MPMS 9.3 and API MPMS 10.4 provide guidance for determining $\boldsymbol{\rho}_b$ and S&W values from a flow proportional composite sample.

While some operating companies generate measurement tickets manually, a LACT flow computer and/or SCADA system can automate the calculations and maintain an audit trail. Emerson flow computer solutions can automate NSV calculations and maintain an audit trail per API MPMS 21.2 requirements.

Conclusion

Emerson Process Management has considerable experience automating LACT units and generating measurement tickets electronically either at a LACT unit or remotely. We have application expertise in the areas of automation, flow and pressure/temperature measurement on LACT units. Contact a local Emerson Process Management sales office for details.

Micro Motion, Inc.

About Micro Motion

For over 35 years, Emerson's Micro Motion has been a technology leader delivering the most precise flow, density and concentration measurement devices for fiscal applications, process control and process monitoring. Our passion for solving flow and density measurement challenges is proven through the highly accurate and unbeatable performance of our devices as well as the quality of our services.

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