Troubleshoot LACT Pump Issues with Coriolis Meter Diagnostics

Introduction

Lease Automatic Custody Transfer (LACT) units are used to measure the Net Standard Volume (NSV) of crude oil produced at a production lease. Micro Motion white paper number WP-001979 provides a detailed description of LACT unit operation and NSV calculations. This document will discuss using Coriolis meter advanced diagnostics and datalogging to troubleshoot common LACT pump system application issues.

LACT pump systems

Many LACT units incorporate two pumps. There is a charge pump that is used to generate flow through the LACT sales meter or divert flow of unmerchantable oil. A second pipeline injection pump is at the LACT outlet and is used to boost the pressure of the flowing stream for input to a gathering pipeline. Charge pumps are generally installed on a LACT skid while pipeline injection pumps may or may not depending on the design.

A less common design incorporates a third pump called a tank booster pump. These are used when a LACT unit is located at a distance from the stock tank outlet and sufficient input pressure is required by the LACT charge pump.

Charge and tank booster pumps are generally centrifugal technology which provides a steady flow through a LACT sales meter.

Pipeline injection pumps are often some form of a positive displacement (PD) technology like gear, piston, or progressive cavity. PD pumps can generate a high discharge pressure.

Centrifugal Pump Net Positive Suction Head (NPSH) requirements

Centrifugal pumps require a positive pressure at the inlet to operate properly. NPSH on a LACT charge pump is created by the upstream stock tank oil level minus pressure dropped across piping and (plus or minus) elevation differences between the stock tank outlet and charge pump center line. Insufficient NPSH on a LACT charge pump will lead to unstable flow output and can create cavitation upstream of a sales meter. Poor LACT sales meter proof run to run repeatability will result.

NPSHr-Net Positive Suction Head required

NPSHr is a manufacturer specified value in feet of water head to prevent cavitation. A standard test method to determine NPSHr allows up to a 3% head pressure drop at the pump outlet. Feet of water must be adjusted based on the specific gravity of the oil measured at the LACT (e.g. NPSHr x 1.2 for 0.8 SGU oil). Figure 1. below shows an example centrifugal pump curve which can be used to determine NPSHr.

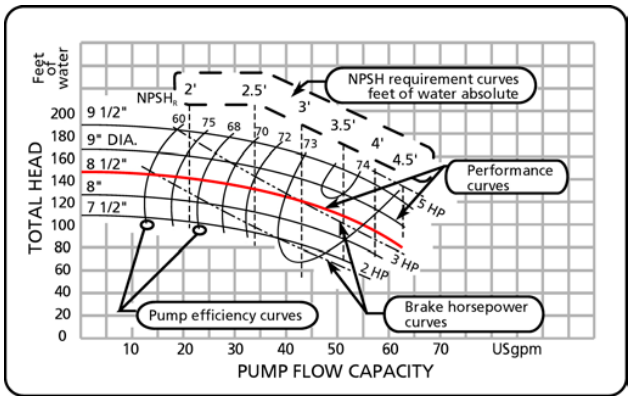

Figure 1.

NPSHa-Net Positive Suction Head available

NPSHa considers the effects of atmospheric pressure and liquid vapor pressure at the pump inlet.

$$NPSH_A = H_a + H_s - H_{vp} - H_f$$

Where:

H_a = Atmospheric Head-Atmospheric pressure in feet of head acting on the liquid (e.g. 34 ft of water @14.7 psia).

H_s = Height Free Surface-Number of feet between the free surface of the liquid and centerline of the pump impeller. Free surface of liquid is the minimum operating stock tank level in a LACT system.

H_{vp} = vapor pressure of the liquid in feet of head.

H_f = friction losses in suction side piping in feet of head.

NPSHa should be evaluated and be at least 10% greater than NPSHr to prevent charge pump issues.

General pump installation best practices

Most pump issues result from suction side problems like restricted inlets, insufficient NPSHa (stock tank levels), or insufficient supply capacity to pipeline injection pumps. Minimize inlet pressure drops by using an inlet pipe diameter at least equal to the pump inlet piping and placing a LACT unit as close to a stock tank outlet as practical.

Provide sufficient supply capacity to pipeline injection pumps. Supply capacity is generally higher than output capacity. Some pipeline injection pumps require pulsation dampeners at the pump inlet/outlet. Follow pump manufacturer recommendations for input flow capacity and maintain pulsation dampeners (charge pressure) as required.

LACT pump issues

LACT unit pump issues often become apparent at sales meter proving. Poor run to run repeatability results from cavitating charge pumps, poor sales meter back pressure control due to pump interaction, or insufficient supply to a pipeline injection pump.

Troubleshooting LACT pump issues

Stop flow through the LACT sales meter and run Smart Meter Verification (SMV). Datalog (1 second intervals) drive gain, volume flow rate, and density under no flow conditions. Expectations are drive gain, volume flow rate, and density are stable and SMV passes.

Continue to log data and start flow through the LACT. Log data can look like the following graphs (Figures 2-4). A pattern is cyclical drive gain, volume flow rate, and to a lessor extent density while flowing.

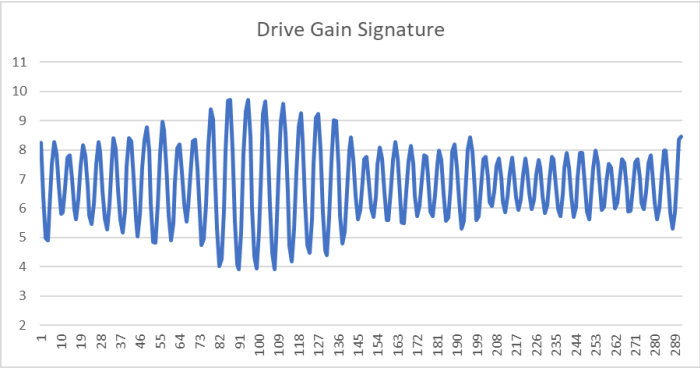

Figure 2.

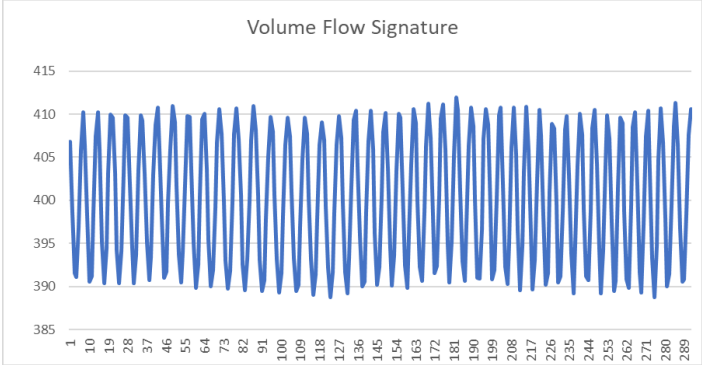

Figure 3.

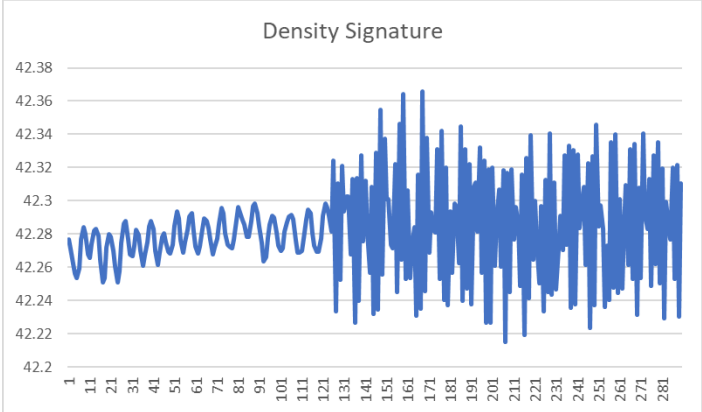

Figure 4.

Walk down the installation and look for pressure indicators. A best practice is to put a differential pressure indicator across a strainer which can be used to determine whether it is plugged. If an indicator is not present pull and inspect the strainer basket for blockage. Cavitating charge pumps have a fluctuating discharge pressure. If a pressure gauge on the charge pump outlet is not stable NPSHa should be evaluated.

If a charge pump outlet is stable, ensure the sales meter back pressure is sufficient and stable. Most LACTs have a mechanically adjustable back pressure control valve which can be used to increase or stabilize pressure at the sales meter. API MPMS Ch. 5.6 includes recommendations for minimum back pressure at the meter outlet.

Ensure that pulsation dampeners (if required) are charged properly and the pipeline injection pump inlet capacity is being satisfied by the charge pump or additional volume (e.g. expanded pipe diameter) at the injection pump inlet.

Conclusion

LACT measurement systems may include multiple pumps that must be applied properly.

Centrifugal charge pumps require a minimum NPSHa (stock tank level) to prevent cavitation.

PD pipeline injection pumps must be supplied with sufficient input capacity which is often multiples of output capacity depending on the pump design.

Coriolis meter advanced diagnostics and datalogging capabilities are useful to diagnose LACT pump issues.

Emerson personnel have a great deal of field experience which can be leveraged to assist in troubleshooting LACT system issues.

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