

PRODUCED WATER MEASUREMENT: MAINTAINING MEASUREMENT INTEGRITY IN A DIRTY ENVIRONMENT

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ABSTRACT

Produced water measurement is often assumed to be a simple application due to the low value of the product. In reality, it presents some of the most difficult measurement challenges in the oil and gas industry. High solids content; oil carryover, scale, and unstable flow conditions can quickly degrade meter performance and lead to significant measurement error.

This paper discusses real-world challenges associated with produced water measurement, with a focus on magnetic flowmeters (mag meters). It highlights the limitations of diagnostics in dirty service, the importance of proper installation, and the necessity of routine validation. Field examples demonstrate how fouling impacts measurement accuracy and how proactive maintenance strategies improve performance and reliability. While other technologies such as Coriolis, turbine, differential pressure, and ultrasonic meters are available for produced water measurement, this paper focuses primarily on magnetic flowmeters due to their practicality and performance in this application.

INTRODUCTION

Produced water measurement plays a critical role in both operational performance and financial accountability. While the product itself has a low value per barrel, inaccuracies in measurement can result in significant volume imbalance, operational inefficiencies, and unintended revenue loss.

Unlike clean water applications, produced water contains oil, solids, sludge, scale, and entrained gas. These conditions create a dynamic and often unpredictable measurement environment. As a result, measurement systems must be actively managed rather than treated as “install and forget” solutions.

The insights and observations presented in this paper are based on direct field experience and operational data gathered while working in produced water measurement environments.

CHALLENGES OF PRODUCED WATER MEASUREMENT

Produced water systems introduce several factors that negatively impact measurement accuracy:

- Oil carryover that coats electrodes and affects signal quality
- Solids, sludge, and scale accumulation inside the meter
- Entrained gas causing unstable measurement conditions
- Rapidly changing conductivity and fluid properties
- Poor installations that distort flow profiles

These conditions often occur simultaneously, creating an environment where measurement degradation happens quickly. In addition, the low economic value of produced water makes it difficult to justify expensive measurement upgrades.

MEASUREMENT OPTIONS AND LIMITATIONS

There are many flow measurement technologies available, and most of them perform well in the right application. The challenge with produced water is that it combines the exact conditions these meters struggle with: solids, oil, entrained gas, and constantly changing fluid properties.

Coriolis meters provide excellent accuracy and density measurement, which can help identify oil carryover. However, they are sensitive to entrained gas, and buildup can affect tube vibration and lead to drift. Cleaning often requires removing the meter from service, creating operational downtime. Combined with high cost, they are difficult to justify for a product worth only cents per barrel.

Inline ultrasonic meters improve accuracy by correcting for flow profile, but they rely on a clean signal path. Oil, solids, and gas degrade signal quality, leading to unreliable measurement. Increasing the number of paths does not solve this issue. It simply provides more data from a degraded signal. While ultrasonic meters can achieve high accuracy in ideal conditions, they come with a cost that is difficult to justify for produced water applications.

Wedge meters perform better than traditional DP meters in dirty service but still rely on pressure-based calculations. Changes in fluid properties and buildup can cause drift, and the system requires multiple components, increasing complexity and potential failure points.

Turbines and paddle meters rely on moving parts. In produced water, solids, and buildup cause wear, slowing or stopping measurement. In dirty service, moving parts are a disadvantage.

There are many technologies available, but produced water is not the ideal application for any of them. That is why operators rely on magnetic flowmeters not because they are perfect, but because they survive the longest and provide the most reliable measurement over time.

MAG METER DIAGNOSTICS IN PRODUCED WATER

Magnetic flowmeters provide several diagnostic indicators used to evaluate performance:

- Electrode Resistance (ER)
- Electrode Coating
- Electrode Signal Stability (ERS)
- Signal-to-Noise Ratio (SNR)
- Empty Pipe Detection

In controlled environments, these diagnostics respond gradually and predictably. However, field experience shows that in produced water service, diagnostic values often change rapidly. In many cases, fouling occurs faster than diagnostics can provide early warning.

As buildup develops, electrode resistance increases, coating values rise, and signal quality degrades. This leads to unstable readings and false reductions in measured volume.

Trending multiple diagnostics together is better than relying on a single indicator. However, diagnostics do not always behave as expected in produced water service. Routine validation and cleaning are necessary, even when the meter appears to be operating normally.

Diagnostics were developed in a clean water environment, not a produced water environment, and should not be interpreted the same way.

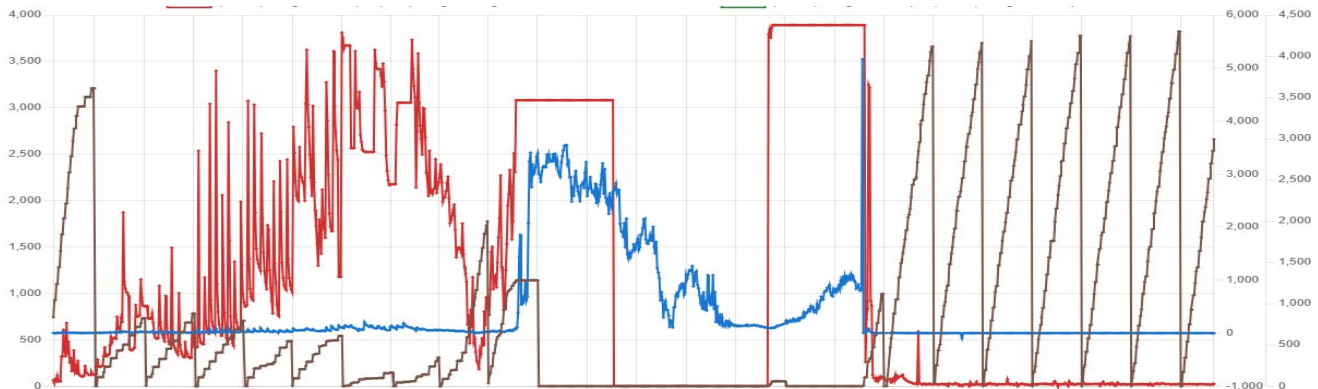
FIELD OBSERVATIONS AND CASE STUDY

Field observations show that measurement degradation can occur even without operational changes.

In one case, a mag meter showed a gradual decline in reported volume. Diagnostic alarms related to electrode coating and resistance were triggered prior to any field visit. Upon inspection, significant buildup was found on the electrodes. After cleaning, diagnostic values returned to baseline and measurement accuracy was restored.

- (CRGY) Conger - Receipt - (CRGY) Conger - Receipt - Daily Total
- (CRGY) Conger - Receipt - (TCE) Conger - Diagnostics - Empty Pipe Value
- (CRGY) Conger - Receipt - (TCE) Conger - Diagnostics - Electrode Resistance Value

Figure 1. Diagnostic trend showing flow degradation and mag meter health indicators



In another example, a meter appeared to be operating normally but was validated against a clamp-on ultrasonic meter and found to be underreporting flow by approximately 15%. After cleaning, the error was reduced to less than 3%.

INSTALLATION CONSIDERATIONS

Many measurement issues attributed to meter performance are caused by improper installation.



Downstream of mod-valve

Improper straight run

Figure 2. Examples of poor installations in produced water service



Transition of pipe size and T directly downstream

Turbulence and distorted velocity profiles significantly affect measurement accuracy. While mag meters are forgiving, poor installation can prevent stable performance.

Even in a dirty system, installation plays a critical role. Maintaining a full pipe, avoiding gas traps, and proper grounding improve stability.

While most manufacturers recommend 5D upstream and 2D downstream, field experience shows better results using 5D upstream and 5D downstream. You must give the meter a chance to measure a stable flow rate.



Figure 3. Example of proper mag meter installation

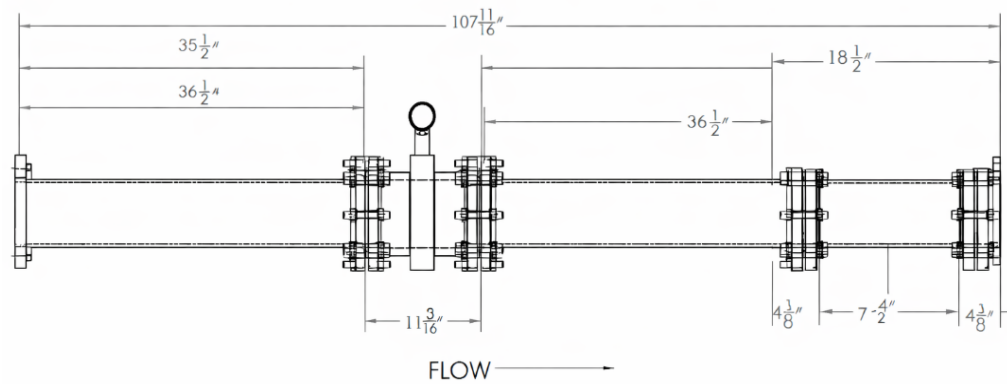


Figure 4. Diagram of 6-inch stainless steel meter run assembly

A poor installation guarantees problems; a good installation delays them.

VALIDATION AND PROVING METHODS

Routine validation is essential due to rapid fouling.

Methods include:

- Clamp-on ultrasonic comparison
- Facility balance monitoring (inlet vs outlet)
- Master meter proving where available



Validation using clamp
on ultrasonic

- Facility balance monitoring (inlet vs outlet)
- Master meter proving where available

Figure 5. Clamp-on ultrasonic validation of a produced water meter

Many facilities do not include permanent proving infrastructure due to cost. As a result, operators rely on field validation techniques and operational experience.

To supplement this, internal proving loops with master meters can be used to validate meters removed from service under controlled conditions.



Internal prover loop with master meter

Figure 6. Internal proving loop with master meter

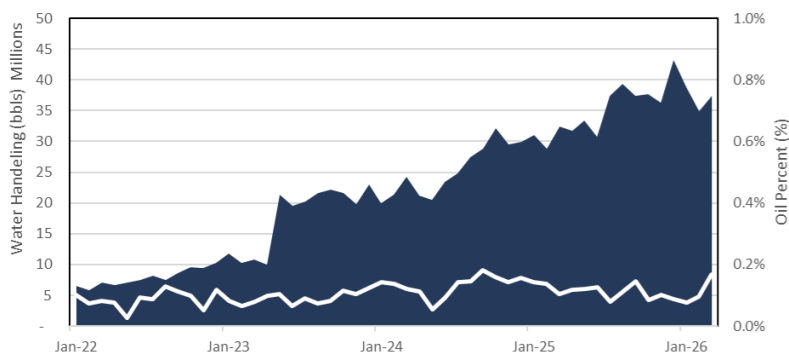
If measurement is not verified, it is assumed.

OPERATIONAL AND ECONOMIC IMPACT

Poor separation at production facilities can result in oil sent into the water system. This leads to:

- Lost revenue for the operator
- Increased processing at disposal facilities
- Additional solids and buildup in the system

Disposal facilities often recover and sell skim oil from produced water. While this creates revenue for the disposal operator, it represents a loss for the producer. As shown in Figure 7, skim oil recovery trends alongside water injection volumes.



Skim oil vs water injected.

Figure 7. Skim Oil Recovery vs Water Injection Volume

Source: Tayler Seal, WaterBridge Infrastructure

Accurate water transfer measurement helps identify these issues early and enables corrective action.

MAINTENANCE STRATEGY

In produced water service, maintenance is part of the measurement strategy.

An effective approach includes:

- Establishing baseline diagnostic values
- Trending key diagnostics
- Performing routine validations

- Investigating sudden volume changes
- Scheduling periodic cleaning

Fouling is unavoidable. The goal is to identify and manage it before it impacts measurement accuracy.

EXTENDING METER RUNTIME

Surface treatments and coatings have been applied to reduce buildup inside meter runs. Field testing has shown significant improvements in runtime and performance.

In one application:

Figure 8. Meter condition before and after surface treatment



Fig. 1 - One week in service before treatment

Fig. 2 - 90+days in service after treatment

- Maintenance frequency was reduced from weekly to monthly or longer
- Validation accuracy improved significantly
- Technician time and maintenance costs reduced

While results vary, these treatments provide a practical solution for improving reliability in harsh environments.

CONCLUSION

Produced water measurement is not about installing the most accurate meter; it is about maintaining confidence in the measurement over time.

It is not a system that can be installed and left unattended. It requires continuous monitoring, validation, and maintenance.

Key takeaways include:

- Diagnostics behave differently in dirty service
- Installation quality significantly impacts performance
- Validation is essential to ensure accuracy
- Maintenance must be proactive

Produced water measurement is not just about installing meters; it is about maintaining confidence in the measurement.