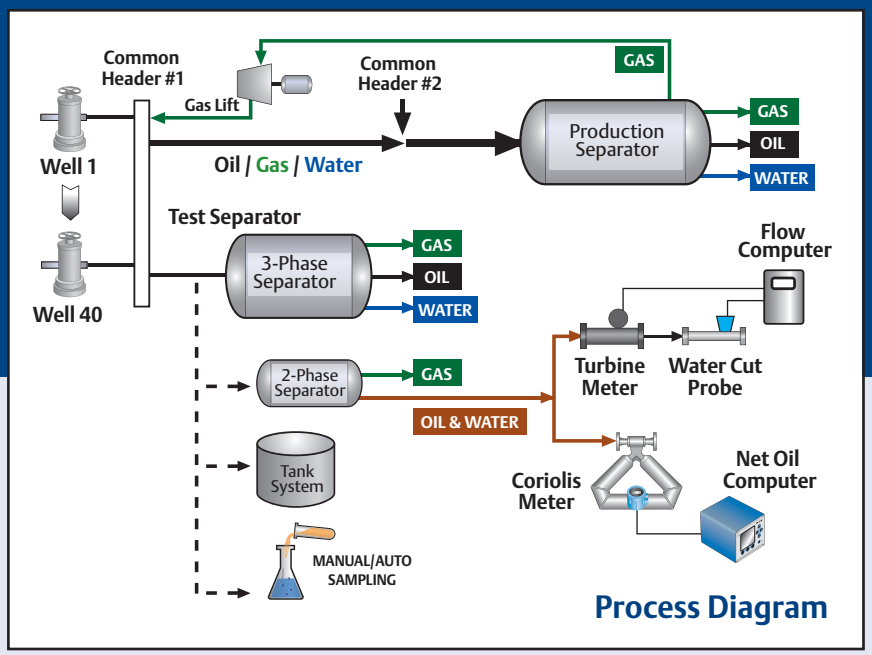
Process Solutions Guide

Production Management

Micro Motion®

EMERSON™
Process Management



Process Diagram

Key Benefits

- Improve availability of wells and facilities
- Manage declining production and dynamic production characteristics
- Improve reservoir modeling
- Reduce cost of maintenance and operations

Proven Coriolis Applications

- Gas lift
- Volume measure of oil, gas and produced water
- Net oil / water cut

Process Overview

Production management involves establishing and maintaining optimal hydrocarbon production rates (oil / natural gas) while maximizing the overall recovery of the hydrocarbons available in the reservoir (yield). Production facilities are either oil or natural gas predominant and depending upon the type of reservoir or production methodology employed can produce various combinations and quantities of oil / condensate, natural gas and water.

Well production is dependent upon the rate at which hydrocarbons flow toward the well bore and the reservoir pressure available to move the fluids to the surface for production. Over time, well production is typically assisted through artificial lift technology to help pump produced fluids to the surface. This can involve surface rod pumps, Electric Submersible Pumps, plunger lift or gas lift systems. Decline in reservoir pressure is countered with Secondary Recovery methods that involve the injection of natural gas or water back into the reservoir through injection wells to maintain reservoir pressure.

The produced fluids from each well are measured to determine the volume production rate of oil, natural gas and water from each well in the field. Well production test facilities can be located at each well site or at a centralized location. The concepts behind a centralized facility are outlined in this document as they can be equally applied to the well pad facilities.

Production from a group of wells is piped to a common header with a valve arrangement to allow the production from any one well to be directed to a test facility while the combined production from the remaining wells is sent to a centralized production separator. Several common headers may feed into one production separator where the fluids are spit into their individual components – water, oil and natural gas. The volume of each produced fluid is measured and sent to the appropriate treatment, storage and/or disposal facility.

Different methods for determining the volume of natural gas, oil and water can be employed at the testing facility. The more common methods are:

- A small three phase separator that breaks the produced fluids into their individual components for volume measurement.
- A two phase separator that separates the natural gas from the liquids (oil and water) and then utilizes a meter to measure the total liquid flow rate in conjunction with some method for determine the water cut (% of water in the oil) so that the volume flow rate of the oil and water can be calculated. A water cut measurement is accomplished with water cut analyzers or probes, a density based determination method utilizing Corolis meters or a manual sample that is analyzed in a laboratory.

Process Overview Continued

- A tanking system that allows gas to dissociate from the liquids and the oil and water to stratify so that the level of each fluid can be measured to determined their respective volumes. In some cases the tank may be used only to determine the total volume of liquids and the water cut determined through laboratory analysis.

Well production tests are typically conducted over an 8-24 hour time frame every 10 to 30 days. The sum of the individual well production rates are compared to the total production rates measured at the production separator to determine allocation factors. The allocation factors are used to correct well production rates for uncertainties in the well test programs. The adjusted well production rates are used to update the characterization of the reservoir and may be used to determine payments due to partners or government agencies.

Customer Benefits

DELIVERABLES: **Establish and maintain optimal hydrocarbon product rates for individual wells without impacting the overall yield from the reservoir.**

Challenge:

- Declining production
- Reservoir characterization
- Dynamic well production characteristics

Gas lift operations must maintain the optimal gas injection to liquid production flow ratio Sub optimal injection rates can reduce oil production rates or result in interrupted production due to hydrate formation or freezing at the injection choke. The injection rates must be monitored and set in relation to the different production characteristics of each well, changing well production characteristics and variations in natural gas supply.

Routine well production tests provide essential data for setting optimal production rates, managing the natural decline in well production and early detection of production changes. Significant overall well test flow uncertainties (±40% @ 90% confidence) can be encountered and is influenced by a number of parameters including measurement drift, flow device accuracy and the availability of test facilities to maintain optimal test programs.

Solution:

- Accurate, reliable and representative production data
- Early detection of well production changes

The reliability and measurement performance of Coriolis meters over a wide flow turndown provides continuous and accurate volume measurements to set and maintain optimal gas injection rates. This flexibility in flow measurement helps maximize the economic gain (cost of gas versus incremental production) and avoid on oil production wells.

Annual Revenue Increase (x $1000 @ $65 / bbl)

	Number of wells			
bpd production increase	1	5	10	20
1	$23	$118	$237	$474
5	$118	$593	$1,186	$2,372
10	$237	$1,186	$2,372	$4,745

Coriolis technology provides accurate and sustainable volume measurement in production measurement applications (oil, natural gas, water) where changing fluid properties, flow regimes/profiles, turndown and entrained gas would normally impact the measurement performance of conventional volume meters. The non-mechanical design of Coriolis makes it a more reliable device when produced fluids contain abrasive materials (sand) and/or exhibit surging and gas slug flow characteristics. The result is more accurate and reliable production flow data for better production / recovery decisions and the early detection of well bore problems.

DELIVERABLES: Reliable and consistent production

Challenge:

- Availability of wells and facilities

Data from well production testing provides insight into changes in production characteristics such as the Gas-Oil Ratio or water cut. Sudden changes or consistent trends may be indicative of abnormal situations occurring in the reservoir (water breakthrough) or well bore problems (scaling) that can result in stopping well production for several days to conduct costly well maintenance programs or remedial actions. The same data is used to assess hydrocarbon revenue against the cost of production to make decisions about when to abandon a well.

Field device equipment failures, degradation in measurement performance and abnormal process unit situations can contribute to diminished or interrupted hydrocarbon production. Minimizing these events through the adoption of newer or better technology must be achieved within budget constrains which balance initial capital cost against total cost of ownership and the overall return on investment.

Solution:

- Better production data for making decisions regarding abandonment & early detection of well bore, process & reservoir problems
- Reliable field devices with a high ROI

Coriolis meters contribute to more accurate and reliable well production test data to reduce the overall uncertainty. Utilizing the density measurement capabilities of the sensor for water cut determinations helps to maintain desired uncertainty levels through oil continuous, transition, and water continuous stages of production. Reductions in uncertainty means changes in well production characteristics can be recognized sooner with a higher degree of confidence to minimize lost production events, premature well abandonment or situations that impact reservoir recovery.

The reliability of Coriolis meters ensures critical flow measurement points are available for continued or optimal operation of production wells, well test facilities and production separators. Multivariable technology (density, mass, temperature, volume) and diagnostics provide early detection of abnormal process situations such as gas carry under, liquid carry over and/or oil in the water leg of test and production separators

Emerson's Micro Motion range of products, lower cost of ownership and potential for higher return in various applications help to justify the technology in new or refurbished facilities.

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DELIVERABLES: **Minimizing the costs associated with field device, well and overall facilities maintenance and operations.**

Challenge:

- Decline in "experienced" operation resources
- Widely dispersed Infrastructure / remote locations
- Aging facilities in demanding applications
- Budgets linked to declining production

The availability of experienced production, operations and maintenance personnel can significantly impact the early recognition of problems, the ability to identify root cause issues and effectively implementing corrective actions.

Changing and demanding measurement conditions in maturing field facilities ultimately increases the potential for measurement performance degradation and/or equipment failures over time. Combine this with widely distributed facilities, often in remote areas, and it is easy to experience reductions in field personnel productivity (operator interventions) and higher operating costs (maintenance events).

Effective management of operation / maintenance, production and capital budgets can be a challenge in a declining production environment.

Solution:

- Less complex, automated systems
- Local or remote diagnostics information
- Reliable, industry tailored products
- Lower cost of ownership solutions

The multivariable capabilities of Coriolis technology, device diagnostics and advanced diagnostics (in-line meter verification) provided field personnel with readily accessible data to recognize potential measurement problems sooner and to identify / resolve device problems faster. This can include abnormal process situations such as gas carry under, liquid carry under or slug flow situations associated with test and production separators.

The sustained measurement performance and robustness (no mechanical parts) of Coriolis flow meter technology minimizes the frequency and duration of operator interventions and maintenance events. Thereby, reducing overall lift costs in maturing facilities.

Coriolis flow and density meters deliver a combination of low maintenance, long term reliability and diagnostics to reduce the overall cost of ownership of field assets. In-line meter verification eliminates the costs associated with pulling and inspecting meters for mechanical wear, erosion or corrosion. Local and remote diagnostics information improves efficiency and effectiveness of maintenance programs.

Recommended Product Solution

Micro Motion ELITE Series , F-Series and Net Oil Computer

Applications

- Gas lift
- Volume measure of oil, gas and produced water
- Net oil / water cut

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