The M-I SWACO 3-Phase Separator is a technically advanced instrumented vessel designed to efficiently separate well effluent into three phases: oil, water, and gas. The vessel was developed for land frac flowback and well test operations and helps operators understand the performance characteristics of a well efficiently and safely.

The separator consists of the vessel, an oil and water flow measuring system that utilizes turbine meters, and electronic gas flow measurement systems with several sampling points. To provide accurate measurements, the vessel is fitted with pneumatic regulators that maintain a constant pressure and a constant liquid level inside the vessel using control valves on the oil, water and gas outlets.

The separator is fitted with a removable and serviceable effluent diverter tube, a mist extractor, a vortex breaker and a weir plate. These components reduce the risk of liquids in the gas line (carry over) and gas in the liquid line (carry under), which affect the flow rate measurements. The separator can also accommodate small quantities of sand or solids, disposed of via the trash line.

The 3-Phase Separator is built in compliance with ASME VIII, Division 1 and NACE MR-0175 for H2S environments. Its skid can also be designed to SEPCO OPS05 and API RP2A standards.

APPLICATIONS
The 3-Phase Separator is used for production well testing and frac flowback operations.

PROS
Not knowing the exact composition and volume of well effluent can hinder sound economic decisions.

SOLUTIONS
During well testing, the M-I SWACO 3-Phase Separator effectively separates well effluent into three phases: oil, water and gas, allowing for correct distribution decisions.

ECONOMICS
The durable and easy-to-maintain 3-Phase Separator provides accurate dissociation and measurement of effluent characteristics to facilitate cost-effective choices. Bypass capabilities allow full production to continue during any repairs that may become necessary.

ENVIRONMENTAL
Should the vessel become over-pressurized, multiple safety valves direct flow to a safe and contained area, thus reducing risk to personnel and the environment.

Accurate, safe separation and measurement of oil, gas and water from well effluent

This information is supplied solely for informational purposes and M-I SWACO makes no guarantees or warranties, either expressed or implied, with respect to the accuracy and use of this data. All product warranties and guarantees shall be governed by the Standard Terms of Sale. Nothing in this document is legal advice or is a substitute for competent legal advice.
During the production test, the produced well effluent, including gas and liquids, flows into the inlet of the separator. The diverter tube redirects the flow providing interference that allows liquids to settle more readily within the separator. Free gas rises to separate these through a mist separator that removes any entrained liquids remaining in the gas. Gas continues to percolate as gas liquids while sliding in the separator. The gas then flows out of the top of the vessel and through the gas outlet, where it is measured and routed into the pipeline, if the viscosity is sufficient, or flared. A metal protector plate blocks any escaping liquid from separating and rising through the gas outlet.

Liquids continue to settle, with the oil separating from the water and rising out of the solution. A weir plate allows this oil to rise into the oil chamber while keeping the water in its chamber. The level control values in both the oil and water outlets allow the separator to control and measure the quantity of fluids removed, to be processed accordingly. Both the water and oil flows through meters to be measured and processed accordingly. An integral component of the M-I SWACO Product Testing Services, the 3-Phase Separator is available for rental or for sale to third-party customers.

To learn more about the benefits of using our 3-Phase Separator technology, contact your nearest M-I SWACO representative.

3-Phase Separator

Success story

Texas: 3-Phase Separator shines in HPHT sour gas application

The situation

A major operator in the Haynesville Shale required a reliable hostile service equipment package for high-pressure, high-temperature (HPHT) sour gas testing. In the event of over-pressurization and exposure to H₂S environment, the separator would include Electronic Flow Measurement for improved accuracy and real-time data capabilities to meet the client’s specific needs.

The results

Use of the M-I SWACO 3-Phase Separator as part of the high-pressure, high-volumes, 15,000 psi working pressure equipment package allowed M-I SWACO to successfully deliver and execute a solution that met the client’s technical objectives. The design of this high performance AF 3-Phase Separator increased production capacity and provided a solution with no-wear production time (WPT) required to the separator. The overall equipment package allowed the customer to process more than 98% of gas well liquids per day of gas, with water removed exceeding 1,800 bbl/day.
The M-I SWACO 3-Phase Separator is a technically advanced instrumented vessel designed to efficiently separate well effluent into three phases: oil, water, and gas. The vessel was developed for land frac flowback and well test operations and helps operators understand the performance characteristics of a well efficiently and safely.

The separator consists of the vessel, an oil and water flow measuring system that utilizes turbine meters, and electronic gas flow measurement systems with several sampling points. To provide accurate measurements, the vessel is fitted with pneumatic regulators that maintain a constant pressure and a constant liquid level inside the vessel using control valves on the oil, water and gas outlets.

The separator is fitted with a removable and serviceable effluent diverter tube, a mist extractor, a vortex breaker and a weir plate. These components reduce the risk of liquids in the gas line (carry over) and gas in the liquid line (carry under), which affect the flowmeter measurements. The separator can also accommodate small quantities of sand or solids, disposed of via the trash line.

The 3-Phase Separator is built in compliance with ASME VIII, Division 1 and NACE MR-0175 for H2S environments. Its skid can also be designed to SEPCO OPSO55 and API RP2A standards.

Accurate, safe separation and measurement of oil, gas and water from well effluent

APPLICATIONS
The 3-Phase Separator is used for production well testing and frac flowback operations.

PROS:
- Knowing the exact composition and volume of well effluent can hinder sound economic decisions.

SOLUTIONS:
- During well testing, the M-I SWACO 3-Phase Separator effectively separates well effluent into three phases: oil, water and gas, allowing for correct distribution decisions.

COSTS:
- The durable and easy to maintain 3-Phase Separator provides accurate dissection and measurement of effluent characteristics to facilitate cost-effective choices. Bypass capabilities allow full production to continue during any repairs that may become necessary.

ENVIRONMENTAL:
- Should the vessel become over-pressurized, multiple safety valves direct flow to a safe and contained area, thus reducing risk to personnel and the environment.

The separator is fitted with a removable and serviceable effluent diverter tube, a mist extractor, a vortex breaker and a weir plate. These components reduce the risk of liquids in the gas line (carry over) and gas in the liquid line (carry under), which affect the flowmeter measurements. The separator can also accommodate small quantities of sand or solids, disposed of via the trash line.

The 3-Phase Separator is built in compliance with ASME VIII, Division 1 and NACE MR-0175 for H2S environments. Its skid can also be designed to SEPCO OPSO55 and API RP2A standards.

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Drying the production test, the produced well effluent, including gas and liquids, flows into the inlet of the separator. The diverter tube redirects the flow providing instructions that allow liquids to settle more readily within the separator. Free gas then separates through a mist eliminator that removes any entrained liquids remaining in the gas. Gas continues to percolate out of liquids while settling in the separator. The gas then flows out of the top of the vessel and through the gas outlet, where it is measured and put into the pipeline (for the volumes of gas and liquids are isolated, or flared. A metal protector plate blocks any opening liquid from entering and rising through the gas outlet.

Liquids continue to settle, with the oil separating from the water and rising out of the separator. A weir plate allows the oil to pass into the oil chamber while keeping the water in its container. The level control valve opens on both the oil and water outlets allow the operator to control and measure the quantity of fluids removed, to be processed accordingly. Both the water and oil gas through meters to be measured and processed accordingly.

An integral component of the M-I SWACO Product Testing Services, the 3-Phase Separator is available for rental or for sale through our specialists.

To inquire about the benefits of using our 3-Phase Separator technology, contact your nearest M-I SWACO representative.

**Success story**

**Texan 3-Phase Separator shives in HPHT sour gas application**

**The situation**

An operator in the Haynesville Shale required a reliable hostile service equipment package to be high-pressure, high-temperature, high-concentration oil and gas well in an HPHT environment.

**The solution**

After analyzing the customer’s requirements, M-I SWACO recommended a service delivery plan consisting of a high-pressure, high-temperature, high-concentration HPHT Separator. The 42-in. HPHT 3-Phase Separator was designed as part of a package. Critical to the operation was the ability of the separator to deliver longer retention times for better separation and the incorporation of multiple pressure relief valves to protect personnel and the environment against vessel over-pressurization and exposure to H₂S gas. In addition, the recommended 3-Phase Separator would include Electronic Flow Measurement for improved accuracy and real-time data acquisition to meet the client’s specific needs.

**The results**

Use of the M-I SWACO 3-Phase Separator as part of the high-pressure, high-temperature, high-concentration environment package allowed M-I SWACO to successfully deliver and operate a solution that met the client’s technical objectives. The design of this high-performance 3-Phase Separator increased the separator footprint with no-wick production to HPHT criteria for the separator. The overall equipment package allowed the customer to process the well, producing greater than 30 MMcf/day of gas, with water rates exceeding 7,000 bbl/day.

**Features**

- Available in multiple configurations, sizes, and pressure ratings to meet individual customer needs
- Skid required for easy transport
- Multiple safety valves to control flow in the event of over-pressurization
- Designed to meet all applicable specifications for rental service, including 2½”
- Replaceable inlet diverter tube allows operators to easily check flow operation during use
- External float chambers allow operators to easily check float operation during use
- Bypass capabilities allow for maintenance, repairs and replacements without having to shut in the well
- Corroding capabilities of 1½ fluid phases prevents options on how to distribute output

**Advantages**

- Effectively separates free gas, oil, and water from well effluent
- Unاصرnsed production for maintenance and repairs
- Designed to withstand the corrosive environment for extended vessel life
- Safety for use in HP environments
- Low operational life
- Easily transportable
- Provides cost-effective choices
- Environmentally acceptable
- Provides single phase surface sampling and flow monitoring over a wide range of flow rates
- Less maintenance design

**Mechanical Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (in)</td>
<td>30” or 42”</td>
</tr>
<tr>
<td>Height (ft)</td>
<td>48” or 60”</td>
</tr>
<tr>
<td>Hub size</td>
<td>4” or 8” and 12”</td>
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<tr>
<td>Drain connection</td>
<td>8” and water</td>
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<tr>
<td>Material</td>
<td>SA516-70, A36</td>
</tr>
<tr>
<td>Pressure</td>
<td>1440 psi on 42” vessel, 2000 psi on 30” vessel</td>
</tr>
<tr>
<td>Maximum Design Temperature</td>
<td>200°F (93°C) on 30”, 125°F (52°C) on 42”</td>
</tr>
<tr>
<td>Maximum Design Pressure</td>
<td>1000 psig on 42” vessel, 600 psig on 30” vessel</td>
</tr>
<tr>
<td>Inlet</td>
<td>3” female</td>
</tr>
<tr>
<td>Outlet</td>
<td>2” male</td>
</tr>
<tr>
<td>Gas Outlet</td>
<td>Gas Well Testing 3-Phase Separator</td>
</tr>
<tr>
<td>Oil Outlet</td>
<td>1 – 4” Oil and Water</td>
</tr>
<tr>
<td>Water Outlet</td>
<td>1 – 6” Oil and Water</td>
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</tbody>
</table>

**General Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>Gas Well Testing 3-Phase Separator</td>
</tr>
<tr>
<td>Available Sizes</td>
<td>30”, 42”</td>
</tr>
<tr>
<td>Maximum Working Pressure (PSIG)</td>
<td>1000 psi on 42” vessel, 600 psi on 30” vessel</td>
</tr>
<tr>
<td>Maximum Design Temperature</td>
<td>200°F (93°C) on 30”, 125°F (52°C) on 42”</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>SA516-70-70, A36</td>
</tr>
<tr>
<td>Pressure Safety Valve (PSV)</td>
<td></td>
</tr>
<tr>
<td>Liquid Level Controls</td>
<td></td>
</tr>
<tr>
<td>Level and Flow Monitoring</td>
<td></td>
</tr>
<tr>
<td>Measurements 1-4”</td>
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</table>

**Application Standards**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>ASME Section VIII, Division 1</td>
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</tr>
<tr>
<td>AWWA D111 Class H (CV)</td>
<td></td>
</tr>
<tr>
<td>AWWA D111 Class I (CV)</td>
<td></td>
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<tr>
<td>NACE MR0175</td>
<td></td>
</tr>
<tr>
<td>Class I Division I (UL, Exp)</td>
<td></td>
</tr>
<tr>
<td>Lethal Service (H₂S)</td>
<td></td>
</tr>
</tbody>
</table>

**3-Phase Separator**
During the production test, the produced well effluent, including all gas and liquids, flows into the inlet of the separator. The diverter tube redirects the flow providing separation that allows liquids to settle more readily within the separator. Free gas then separates from these through a mist extractor that removes any entrained liquids remaining in the gas. Gas continues to percolate and exit all liquids while sitting in the separator. Gas then flows into the top of the vessel and through the gas outlet, where it is measured and put into storage for future use. A metal protector plate blocks any escaping liquid from entering and rising through the gas outlet. Liquids continue to settle, with the oil separating from the water and rising out of solution. A weir plate allows the oil to enter into the oil chamber while keeping the water in its chamber. The level control values on both the oil and water outlets allow the operator to control and measure the quantity of fluids removed, to be processed accordingly. Both the water and oil outlet, where it is measured and put into storage for future use. An integral component of the M-I SWACO Product Testing Services, the 3-Phase Separator is available for rental or for sale to third-party customers. To learn more about the benefits of using our 3-Phase Separator technology, contact your nearest M-I SWACO representative.

**Features**
- Available in multiple configurations, sizes, and pressure ratings to meet individual customer needs
- Skid mounted for easy transport
- Multiple safety valves to re-direct flow in the event of over-pressurization
- Designed to meet all applicable specifications for related services, including API 12E
- Removable inlet diverter tube to increase vessel length
- External float chambers allow operators to easily check fluid operation during use
- Bypass capabilities allow for maintenance, repairs and replacements without having to shut-in the well
- Corrugated capabilities of all fluid phases provide options on how to distribute output

**Advantages**
- Effectively separates free gas, oil, and water from well effluent
- Uninterrupted production for extended vessel life
- Safe for use in PSV environments
- Long operational life
- Easily transportable
- Promotes cost-effective choices
- Environmentally acceptable
- Provides single-phase surface sampling and free cooling over a wide range of flow-rates
- Low maintenance design

**3-Phase Separator**

**Mechanical Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Height</strong></td>
<td>2’ 10” female, 3’ male</td>
</tr>
<tr>
<td><strong>Width</strong></td>
<td>2’ 5” male, 2’ 6” female</td>
</tr>
<tr>
<td><strong>Depth</strong></td>
<td>2’ 8” male, 2’ 6” female</td>
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</table>

**Internal Connections**

<table>
<thead>
<tr>
<th>Connection</th>
<th>Specification</th>
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</thead>
<tbody>
<tr>
<td><strong>Gas Outlet</strong></td>
<td>4” NPSM male</td>
</tr>
<tr>
<td><strong>Oil Outlet</strong></td>
<td>2” NPSM male</td>
</tr>
<tr>
<td><strong>Water Outlet</strong></td>
<td>2” NPSM female</td>
</tr>
</tbody>
</table>

**Level and Flow Monitoring**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas Level</strong></td>
<td>0’ 0” - 0’ 4”</td>
</tr>
<tr>
<td><strong>Water Level</strong></td>
<td>0’ 4” - 4’ 0”</td>
</tr>
<tr>
<td><strong>Oil Level</strong></td>
<td>4’ 0” - 4’ 2”</td>
</tr>
</tbody>
</table>

**Performance**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clear Bubbling</strong></td>
<td>1’ 3” - 2’ 4”</td>
</tr>
<tr>
<td><strong>Immiscible</strong></td>
<td>2’ 4”</td>
</tr>
<tr>
<td><strong>Water scout</strong></td>
<td>3’ 1” - 3’ 6”</td>
</tr>
<tr>
<td><strong>Water outlet</strong></td>
<td>3’ 6” - 4’ 0”</td>
</tr>
<tr>
<td><strong>Pressure Safety Valve (PSV)</strong></td>
<td>4’ 0” - 4’ 2”</td>
</tr>
</tbody>
</table>

**Safety**

- 2 sets of 2” (external floats)
- 30” diameter x 120” seam to seam
- Uninterrupted production for extended vessel life
- Bypass capabilities allow for maintenance, repairs and replacements without having to shut-in the well
- Corrugated capabilities of all fluid phases provide options on how to distribute output

**Success story**

**Texaco 3-Phase Separator Shines in HPHT Sour Gas Application**

**The situation**

A major operator in the Haynesville Shale required a reliable durable service equipment package for high-pressure, high-temperature operations, including the handling of a gas well in an HPHT environment.

**The solution**

After analyzing the customer’s requirements, M-I SWACO recommended a service delivery plan comprising a 15K psi working pressure equipment package that included its field proven 3-Phase Separator. The 42-in. HPHT NACE 3-Phase Separator was no gamble on part of a package. Critical to this operation was the capacity of the separator to deliver the longer retention times for better separation and the incorporation of multiple pressure relief valves to protect personnel and the environment against vessel over-pressurization.

**The results**

Use of the M-I SWACO 3-Phase Separator as part of the high-pressure, high-temperature, HP-3 environment package allowed M-I SWACO to successfully deliver and execute a solution that met the client’s technical objectives. The design of the high performance 3-Phase Separator increased the vessel’s internal pressure to its maximum 3,100 psi, allowing Texaco to increase the pressure to 4,500 psi. The vessel was equipped with an in-line pull through nozzle, providing a “near production” test (NPT) solution to the operator. This complete equipment package allowed the customer to process the well, producing greater than 20 MMcf/d of gas, with water remixing 7,000 bbl/day.
The M-I SWACO 3-Phase Separator is a technically advanced instrumented vessel designed to efficiently separate well effluent into three phases: oil, water, and gas. It was developed for land frac, flowback, and well test operations and helps operators understand the performance characteristics of a well efficiently and safely.

The separator consists of the vessel, an oil and water flow measuring system that utilizes turbine meters, and electronic gas flow measurement systems with several sampling points. To provide accurate measurements, the vessel is fitted with pneumatic regulators that maintain a constant pressure and a constant liquid level inside the vessel using control valves on the oil, water, and gas outlets.

The separator is fitted with a removable and serviceable effluent diverter tube, a mist extractor, a vortex breaker, and a weir plate. These components reduce the risk of liquids in the gas line (carry over) and gas in the liquid line (carry under), which affect the flow rate measurements. The separator can also accommodate small quantities of sand or solids, disposed of via the trash line.

The 3-Phase Separator is built in compliance with ASME VIII, Division 1 and NACE MR-0175 for H2S environments. Its skid can also be designed to SEPCO OP55 and API RP2A standards.

APPLICATIONS

The 3-Phase Separator is used for production well testing and frac flowback operations.

PROPERTIES

Not knowing the exact composition and volume of well effluent can hinder sound economic decisions.

SOLUTIONS

During well testing, the M-I SWACO 3-Phase Separator effectively separates well effluent into three phases: oil, water, and gas, allowing for correct distribution decisions.

ECONOMICS

The durable and easy-to-maintain 3-Phase Separator provides accurate downstream measurement of effluent characteristics to facilitate cost-effective choices. Bypass capabilities allow full production to continue during any repairs that may become necessary.

ENVIRONMENTAL

Should the vessel become over-pressurized, multiple safety valves direct flow to a safe and contained area, thus reducing risk to personnel and the environment.

ACCURATE, SAFE SEPARATION AND MEASUREMENT OF OIL, GAS AND WATER FROM WELL EFFLUENT