SIEMENS

U.S. Filter and Monosep Products

Products Introduction
Topics of Discussion Include;

- Flotation Process Description
- Veirsep
- Cyclosep
- Spinsep
- Hydrocyclones
- CPI’s
- AWS filters
- Services
- R&D
## Limitations of Separation Technology

<table>
<thead>
<tr>
<th>Separator Type</th>
<th>Technology</th>
<th>Oil Droplet Removal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>API</td>
<td>Gravity</td>
<td>Down to 150 micron</td>
</tr>
<tr>
<td>CPI</td>
<td>Gravity Coalescer</td>
<td>Down to 50 micron</td>
</tr>
<tr>
<td>DAF, IGF, DGF</td>
<td>Induced Air/Gas Bubbles</td>
<td>Down to 25-30 micron</td>
</tr>
<tr>
<td>Hydrocyclones</td>
<td>Centrifugal Force</td>
<td>Down to 15 – 20 micron</td>
</tr>
<tr>
<td>Centrifuge</td>
<td>Centrifugal Force</td>
<td>Down to 5 – 20 micron</td>
</tr>
<tr>
<td>Coalescer (like TORR System)</td>
<td>Filtration/Coalescing</td>
<td>Down to 2 micron</td>
</tr>
<tr>
<td>UF, RO, Micro, Nano</td>
<td>Membrane</td>
<td>Less than 1 micron</td>
</tr>
</tbody>
</table>
Primary, Secondary, and Tertiary Equipment

Primary Separation
- Hydrocyclones
  - Solid/Liquid
  - Liquid/Liquid
- Corrugated plate separators (CPS)
- Skimmer

Secondary Separation
- Dissolved Gas Flotation (DGF)
  - Spinsep – Vertical Vessel
  - Veirsep
  - Combosep
  - Cyclosep
- Induced Gas Flotation (IGF)
  - Hydrocell
  - Quadricell

Tertiary Separation
- Coalescing filter
- Walnut shell filter
- Cartridge filter
**Applicable Bubble Technology**

**DGF Pump Technology**
- Greater bubble dynamic flexibility
- Reduced maintenance costs
- Capable of dissolving gas into solution
- Bubble sizes ranging from 1 to 100 microns

**IGF Technology**
- Hydraulic or Mechanical design
- Increased maintenance
- Bubble size ranges from 50 to 200 microns

**Sparging**
- Prone to plugging
- Requires vessel isolation for maintenance
- Hazardous during cleaning
Flotation Process

By attaching a small gas bubble to an oil droplet, it will decrease the density of the droplet which will increase the rate at which it will rise to the surface.

- Population of Gas Bubbles
- Size of Gas Bubbles
- Distribution of Gas Bubbles
- Oil Droplet “Rate of Rise”
Dissolved Gas Flotation (DGF)

MONOSEP developed the Brise DGF Pump Technology in 1996.

No need for eductors, mechanical agitators, or sparging tubes.

DGF Technology creates a much smaller bubble, higher population of bubbles and the size can be controlled by the backpressure valve.
DGF Technology

Impeller has dual sides and special seal.

Sub-atmospheric pressure region where the vapor is dissolved/emulsified into micro-fine bubbles.

Therefore, no need for eductors and the maintenance that eductors require.
DGF System Off

DGF System On 5 Seconds

DGF System On 30 Seconds
<table>
<thead>
<tr>
<th>Comparison Factors</th>
<th>Brise DGF Pump</th>
<th>Eductor Technology</th>
<th>Sparge Tube Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexibility of Operation</td>
<td>Very High</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>O &amp; G Removal Efficiency</td>
<td>Very high</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Chemical Usage</td>
<td>Very low</td>
<td>Normal</td>
<td>High</td>
</tr>
<tr>
<td>Bubble Size (Micron)</td>
<td>1 to 100</td>
<td>50 to 1000</td>
<td>25 to 100</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Low</td>
<td>Normal</td>
<td>Excessive</td>
</tr>
<tr>
<td>Recycle Rate</td>
<td>15% to 25%</td>
<td>25% to 100%</td>
<td>NA</td>
</tr>
</tbody>
</table>
DGF vs. IGF Technology Comparison

DGF produces smaller micron gas bubbles than IGF

DGF produces a much greater population of gas bubbles than IGF

DGF can “Dissolve” gas into produced water, whereas IGF induces Gas

40x Magnification
Produced Water Treatment Equipment

- **SPINSEP**
  - Uses specialized cyclonic and flotation technology that removes oil, grease and solids in a single vessel arrangement.
  - “Head-in-Head” design aids in pitch and roll conditions (TLP, Spars, FPSO, etc.)
Spinsep Design Criteria

Single celled vertical vessel for reduced footprint

Designed for <100 ppm inlet TSS

Designed for <300 ppm inlet O&G

Receptive to DGF, IGF, and Sparge technology

Preferred product line for floating production facilities were motion is an issue.
MONOSEP
WAVE SUPPRESSION
P-54

LEVEL OPERATING CONDITION
Wave Suppression Design

(Varying “Pitch and Roll”)

MONOSEP
WAVE SUPPRESSION
P-54

LEVEL OPERATING CONDITION
Compensation for Motion

FSPO MAXIMUM OPERATING CONDITION
6° Roll/Pitch Towards Level Control
(Compensation for Motion)

FSPO MAXIMUM OPERATING CONDITION
6° Roll/Pitch Away From Level Control
Compensation for Motion
Produced Water Treatment Equipment

VEIRSEP

- Incorporates several unique technologies to separate oil and various other contaminants from Produced Water and contaminated wastewater streams.
Veirsep Design Criteria

6 celled (4 flotation cells and 2 quiet separation cells) Horizontal vessel

Designed for <150 ppm inlet TSS

Designed for <600 ppm inlet O&G

Receptive to DGF, IGF, and Sparge technology

Greater retention time equates to greater efficiency
VEIRSEP 3D ANIMATION

SIEMENS
Produced Water Treatment Equipment

CYCLOSEP

- Incorporates several unique methods for removing oil and solids from produced and wastewater streams before it is discharged or injected;
- Improved technology reduces the footprint required for this innovative flotation system.
2 celled vertical vessel

Unique internal cyclone designed for solids separation.

Internal solids hopper designed to trap solids.

Designed for <300 ppm TSS

Designed for <350 ppm O&G

Receptive to DGF, IGF, and Sparge technology
Produced Water Treatment Equipment

Hydrocyclones

- Liquid/liquid, solid/liquid designs
- Maximum separation in a small footprint
- Low weight, important in offshore applications
- Hydrocyclone bundles recently patented
- Used primarily to remove concentrations of oil (200 to 2,000 ppm) from Produced Water as an initial separation step prior to polishing by flotation systems
Primary Separation -- Hydrocyclones

Hydrocyclones

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Liquid/Liquid Hydrocyclone Liner Cross Section
Key Design or Operations Parameters

1. Liquid/Liquid Hydrocyclones **need pressure** to operate. This can be from the HP, IP, or LP Separator, or from a low shear pump.

2. The 2 fluids must be **immiscible**. In most cases, we are separating oil from water in produced water applications.

3. The unit can be mounted in either the horizontal or vertical position. The unit is not sensitive to motion.

4. The tangential inlet provides a smooth transition from linear to angular fluid velocity, avoiding droplet shearing. Hence, **no moving parts**.

15,000 BPD Hydrocyclone
1. The liquid/liquid hydrocyclone is used *primarily* as a primary separator with inlet concentrations of 100 – 10,000 ppm of oil.

2. It can handle up to 30% oil with a larger reject orifice, but this is rare. Normal inlet concentrations are typically 2% or less.

3. The underflow is a very clean water, with typically 30 – 50 ppm of oil content.

4. The overflow is an oil rich stream, with 5 – 15% oil in water (depending upon feed concentration)

5. The reject rate is 2 – 3% of the total flow.
Factors Governing Performance

I. A number of factors influence oily water separation performance:
   1. Droplet Size of the dispersed phase (i.e., oil)
   2. Fluid Temperature
   3. Differential density of the two fluids to be separated.

II. Other factors that affect performance include:
   1. Inlet Concentration
   2. Oil Slugging
   3. Interfacial Tension
   4. Chemical Treatment and Solids
   5. Free and Dissolved Gas Content
Produced Water Treatment Equipment

Induced Gas Flotation

- Hydrocell®, Quadricell®, Megacell separators
  - Well-suited for stable, large volume waste streams
  - Few moving parts and comparatively small footprint
  - Gas-tight design for VOC and/or odor control
Auto-Shell™ Walnut Shell Filters

- Removes nearly all free oil and solids from waste stream
- Deep bed, walnut shell media
- Longer on-line time before oil breakthrough
- Zero upstream flow interruption, preventing feed pump dead heading
Corrugated Plate Separators

- Gravity-design separator

- Corrugated plate interceptor minimizes distance free oil droplets must rise before coming into contact with other oil droplets, facilitating free oil removal
<table>
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<tr>
<th><strong>Flowback Services</strong></th>
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<tbody>
<tr>
<td><strong>Acid Flowback</strong></td>
</tr>
<tr>
<td><strong>Completion &amp; Workover</strong></td>
</tr>
<tr>
<td>♦ The technology can be applied to treat returned fluids, generated by well stimulation, new completions and remedial workover processes, prior to final discharge overboard.</td>
</tr>
<tr>
<td><strong>Zinc Removal</strong></td>
</tr>
<tr>
<td>♦ For well treatment, completion and workover fluids, the discharge of priority pollutants, such as zinc bromide, is prohibited except in “trace amounts” (Per Federal Reg. - NPDES Permit GOM 290000). The Company’s zinc treatment process reduces toxicity levels to below regulatory limits, allowing discharge of waste fluids on-site.</td>
</tr>
<tr>
<td><strong>Pipeline &amp;</strong></td>
</tr>
<tr>
<td><strong>Decommissioning</strong></td>
</tr>
<tr>
<td>♦ The Company’s technology can be used to treat the large amounts of waste fluids and water that are generated by periodic hydro testing, cleaning and/or pigging of pipeline activities</td>
</tr>
<tr>
<td><strong>Drilling &amp;</strong></td>
</tr>
<tr>
<td><strong>Exploration</strong></td>
</tr>
<tr>
<td>♦ The Company’s technology can be utilized to treat waste streams generated by drilling and exploration activities, which vary from contaminated wash and ballast water to emulsified fluids containing drilling fluid, cuttings, seawater, etc.</td>
</tr>
</tbody>
</table>
Reverse Osmosis

Product Description

- The Company sells and rents reverse osmosis systems configured to meet specific customer needs; the Company can custom design, engineer and construct a system ranging from a few hundred gallons to several thousand gallons / day.
- The Company’s patented system has proven to be one of the most effective solutions for producing potable water for the drilling and production sector.

Applications

- Converting seawater into potable water to build water base drilling fluids, completion fluids, etc.
- Treating produced water, frac water and/or pit water into reusable water or treating to NPDES discharge standards
- Treating seawater for Ultra High Pressure (U.H.P.) water blasting for coating operations
- Manufacturing water systems ranging from 10 B.P.D. to 1,000 B.P.D for rental and purchase
- Hydroblasting
CFU (Compact Flotation Unit)

- Incorporates optimal vortex velocities with micro bubble technology within a vessel with reduced retention time for maximum efficiency.

AWS System Redesign

- Eliminated the need for an external scrubber unit along with the associated pump skid and piping. Increased flux rate equating to a smaller vessel.

Coalescing Filter

- Back washable filters used for reducing oil and grease levels to below 5 ppm without the need for frequent change-outs.
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