FloSURE AICD’s can be integrated with Tendeka’s Premium Screen range, offering the ultimate in sand retention, fines tolerance and fluids control.

The FloRight-Ultra is based on Tendeka’s FloMax-Ultra Premium Sand Control Screen using an innovative press-fit assembly method to ensure the highest burst and collapse ratings of the premium mesh layers. The premium screen uses a multi-layer design for support, drainage, filtration, convergence and protection.

- The complete fusion through press fitting of all layers
- Inner shroud for back-up sand control and flow convergence
- High capacity Dutch Twill Weave (150 - 200 micron) and Reverse Dutch Twill (250 - 350 micron) for ultimate formation retention and plugging resistance
- The weave is pressed against the outer and inner screen layers and does not utilize welding
- High strength internal jacket with integral centralizers ensures screen to base pipe stand-off without compromising strength

FloRight-Ultra Screens are designed, manufactured and fully qualified to meet ISO 17824 V1 and Q1 standards.

**CASE STUDY**

**MEDIUM HEAVY OIL (50CP) - 1200M LATERAL**

1 AICD per joint totaling 100 AICD valves per lateral has been configured for 7,500 - 15,000 sbbl/d.

- Screen Length: 40 ft screen joints = 100 joints
- Rate per joint: 15,000 sbbl/d / 100 = 150 sbbl/d/aicd
- Optimum AICD pressure drop: 5 - 10 bar
- Operating range: 60 - 120 rbbl/d/aicd

FloSURE™ AUTONOMOUS ICD
Advanced Inflow Control Technology

FloSURE™ AUTONOMOUS INFLOW CONTROL DEVICE (AICD) is designed to control produced fluids from the entire length of a horizontal well.

The FloSURE™ Autonomous Inflow Control Device (AICD) is an effective solution for increasing oil production over the life of the field. The award-winning FloSURE AICD has been deployed successfully in light and heavy oil wells to overcome water or gas breakthrough and ensure uniform production longevity. The device preferentially chokes unwanted produced fluids whilst promoting production of oil from the entire length of the well.

The valves are deployed with the sand face completion either as an integral part of Tendeka’s FloRight premium and direct wrap screens, or within an independent sub. A DHP Liner hanger along with SealRight™ open hole packers or SwellFix™ swellable packers isolate compartments within the horizontal section of the well to enable the differential inflow control of fluids.

**BENEFITS**

- Variable choke which controls both gas and water in wells
- Gas/water control outperforms passive ICDs
- Levitation disc allows for ream or wash-down and spotting of breaker fluids
- Valve will respond to the velocity of the fluid coming into the well
- Readily configurable for a range of production conditions
- Incorporated into a screen joint without OD protrusion
FLOW PERFORMANCE

FloSure AICD’s behave like passive ICs before water/gas breakthrough, giving a predetermined pressure drop between the reservoir and the completion liner. This choking effect creates a back pressure on higher quality sections of the reservoir, allowing tighter sections to contribute to levelling out the inflow profile from the well. Levelling out of the inflow profile will result in better coning control therefore delaying water or gas breakthrough.

SIMULATION

Tendeka’s proprietary software is used for creation of performance curves for any downhole fluid properties. Regression coefficients for use in reservoir simulators such as Eclipse or steady-state programs like NETool are part of the program output.

Both linear and non-linear regression is used and compared with the physical model to ensure no coefficient divergence. StatOil’s licensed LINEST method is used as well as DATAFIT from Oakdale Engineering.

PRINCIPALS OF OPERATION

The FloSure uses Bernoulli theory – “Sum of Static Pressure, Dynamic Pressure and Friction loss along a streamline is constant”. Low viscosity gas reduces friction pressure and causes very high velocity thereby “sucking” the levitation disc against the seat and increasing oil flow.

TESTING

Testing has demonstrated that the FloSure AICD design controls gas far better than a passive ICD due to the choked flow, the valve remains open while choking upon arrival of water/gas.

PRODUCTION CONTROL/DESIGN VERIFICATION:

- Multi-Phase Full Scale Flow Loop/Full Scale Erosion Test Loop
- High Pressure Gas Test Loop (100 bar)/Vacuum Test Loop - Final Factory Acceptance Testing
- Erosion Testing - 30 bar/10 years/5 ppm
- Erosion prediction matches well with Rabinowicz’s theory

5 STEPS TO IMPROVED FLOW CONTROL

1. COLLECT CLIENT RESERVOIR DATA AND PERFORMANCE REQUIREMENTS

- Res Temperature and Pressure and water
- Stock tank densities (oil, gas, water)
- PVT tables for oil and gas
- Live oil/gas/water densities
- Live oil/gas/water viscosities
- Production Rates (oil, gas, water) - non icd case
- Initial/mid-life/late life
- Initial expected draw-down
- Well length
- Gas control/water control

2. CREATE FloSURE DESIGN DATA

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>TBC</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc</td>
<td>TBC</td>
<td>mm</td>
</tr>
<tr>
<td>Density - water</td>
<td>1.11</td>
<td>g/cc</td>
</tr>
<tr>
<td>Viscosity - water</td>
<td>0.64</td>
<td>cp</td>
</tr>
<tr>
<td>Density - oil</td>
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<td>cp</td>
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<tr>
<td>Density - gas</td>
<td>0.130</td>
<td>g/cc</td>
</tr>
<tr>
<td>Viscosity - gas</td>
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<td>cp</td>
</tr>
<tr>
<td>Target DP</td>
<td>10.00</td>
<td>bar</td>
</tr>
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</table>

3. GENERATE INITIAL FLUID FLOW PERFORMANCE CURVES AND COMPARE WITH PASSIVE ICD DESIGN

![Graph showing FloSure AICD performance vs Passive ICD](image)

4. GENERATE AICD PERFORMANCE COEFFICIENTS

Perform linear regression using StatOil’s linear regression method as well as rigorous multi-variable non-linear regression for NETool and Eclipse simulators as per below equation set:

\[
\Delta P = f(p_{\text{in}}, p_{\text{out}}) \times a_{\text{AICD}} \times q^a
\]

\[
f(p_{\text{in}}, p_{\text{out}}) = \frac{p_{\text{in}}}{p_{\text{out}}} \times \left( \frac{p_{\text{in}}}{p_{\text{out}}} - 1 \right)
\]

\[
p_{\text{in}} = a_{\text{oil}} p_{\text{oil}} + a_{\text{water}} p_{\text{water}} + a_{\text{gas}} p_{\text{gas}}
\]

AICD Equation set for Eclipse / NETool (from SPE 159634)

MULTI-VARIABLE NON-LINEAR (MVNL) REGRESSION

<table>
<thead>
<tr>
<th>AICD SIZE</th>
<th>TR7</th>
<th>UNITS</th>
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<tbody>
<tr>
<td>a_{\text{AICD}}</td>
<td>3.811E-05</td>
<td>Bar/day/kg</td>
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<tr>
<td>u_{\text{cal}}</td>
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<td>cp</td>
</tr>
<tr>
<td>rho_{\text{cal}}</td>
<td>1000</td>
<td>kg/m3</td>
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<tr>
<td>x</td>
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<td>prop</td>
</tr>
<tr>
<td>y</td>
<td>0.510</td>
<td>prop</td>
</tr>
</tbody>
</table>

5. QUALITY CHECK REGRESSION COEFFICIENTS FOR GAS CONTROL ACCURACY

![Graph showing actual versus regression](image)
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