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i-balance : A Fully Automated Managed Pressure Drilling System

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Three ways to drill the well

- **Conventional drilling**
  employs hydrostatic overbalance to prevent influx into wellbore

- **Underbalanced drilling**
  invites influx for improved drilling performance and reduction of formation damage

- **Managed Pressure Drilling**
  discourages influx by application of surface back pressure and any influx that may be incidental is contained with appropriate surface and downhole equipment
Why MPD is needed?

To prevent or mitigate various drilling problems as mentioned below:

- Lost Circulation
- Ballooning and Breathing
- ECD management
- Well Bore Stability issues
- Low Kick Tolerance
- Background Gas
- Formation Damage
- Cementing issues

- Narrow drilling window
- Depleted formations
- Stripping or Tripping Under Pressure
- Pore – Fracture Pressure Uncertainties
Conventional Drilling Vs MPD System

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**In Conventional Drilling**
- **Pumps-off** BHP = $P_{\text{hydrostat}}$
- **Pumps-on** BHP = $P_{\text{hydrostat}} + P_{\text{ann,pressure losses}}$

**Managed Pressure Drilling**
- **Pumps-off** BHP = $P_{\text{hydrostat}} + P_{\text{ann,backpressure}}$
- **Pumps-on** BHP = $P_{\text{hydrostat}} + P_{\text{ann,pressure losses}} + P_{\text{ann,backpressure}}$

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**Diagram:**
- **Static Pressure**
- **Gradient (ESD)**
- **Dynamic Pressure**
- **Gradient (ECD)**

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**Diagram:**
- **Static Pressure**
- **Gradient (ESD)**
- **Dynamic Pressure**
- **Gradient (ECD)**
- **Surface Back Pressure (SBP)**
Automation and its level

High

Level 10: The computer decides everything, acts autonomously, ignoring the human
Level 9: Informs the human only if it, the computer, decides to..
Level 8: Informs the human only if asked, or..
Level 7: Executes automatically, then necessarily informs the human, and..
Level 6: Allows the human a restricted time to veto before automatic execution, or..
Level 5: Executes that suggestion if the human approves, or..
Level 4: Suggest one alternative
Level 3: Narrows the selection down to a few, or..
Level 2: The computer offers a complete set of decision / action alternatives, or
Level 1: The computer offers no assistance: human must take all decisions and actions

Low

M-I SWACO i-balance System

i-balance : A Fully Automated Managed Pressure Drilling System

i-balance is part of an engineered approach that develops a comprehensive pressure management and well plan including:

- equipment selection
- layout and installation
- surface and downhole pressure and flow rate objectives
- operational procedures
- contingency responses, hazard identification
- rig crew training, and regulatory compliance

<table>
<thead>
<tr>
<th>Product</th>
<th>Engineering</th>
<th>Model</th>
<th>Equipment</th>
<th>Typical crew</th>
<th>Services</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>i-balance</td>
<td>Planning and support with VIRTUAL HYDRAULIC</td>
<td>Integrated real-time hydraulics model</td>
<td>Choke Manifold, HPU, PLC, Flow Meter and Back Pressure Pump</td>
<td>2 x Supervisor, 2 x Specialists</td>
<td>Automated BHP control, automated rollovers, early kick detection, dynamic FIT/LOT and flow checks</td>
<td>+/- 5 psi on surface pressure and +/- 35 psi on bottom hole pressure</td>
</tr>
</tbody>
</table>
How i-balance system works?

- Auto-maintain constant bottom hole pressure during drilling and connection as per set point
- Auto-calculate surface backpressure required based on the set point.
- Auto-turn on / off for MPD Back Pressure Pump.
- Real time hydraulics software
- Graphical solution for well monitoring and analysis and able to distribute the multiple displays
- WITS compatible for most of the mud logging / rig system / MWD / LWD.
Applications

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South East Asia Real Results

- Malaysia – Drilling Deepest HP/HPHT Well in Offshore Malaysia (SPE Paper # 167930 MS)
- Malaysia – Managed Pressure Drilling and Cementing in a very narrow window (SPE Paper #168945)
- Thailand – Significantly Reducing Drilling Costs in Extremely HT Wells (SPE Paper #176046 MS)
- Malaysia – MPD and MPC Successfully Applied to Deliver a Defying Exploratory Ultra-HPHT Well in Offshore Malaysia (SPE #173812 MS)
- Malaysia – Running Liner and Cementing in a very narrow mud weight window (SPE #174830)
- Many more real results worldwide.
Potential MPD application in Indonesia area such as:

- **East Java Area** – Total Loss and Kick Zone in Kujung
- **West Java Offshore** – Total Loss and Kick Zones
- **South Sumatera** – Kick and Loss Zone in Baturaja
- **Makassar Straits** – Mapping Drilling Window in Deepwater Exploration
- **Kalimantan Offshore** – Mapping Drilling Window in Borneo Sea HPHT Exploration
- **Any drilling operations in Indonesia** – Safer Drilling Operation with RCD and EKD Installation in Exploration and Development Wells
Highlights

i-balance: A Fully Automated Managed Pressure Drilling System

- **Depend on the application**
  - Reduce costs and drilling time
  - Reduce formation damage and stimulations
  - Minimize Hole Problems such as lost circulation and pipe sticking
  - Mapping Drilling Window
  - Early Kick Detection (EKD)
  - Managed Pressure Cementing
  - Closed Loop Drilling – HSE

- Drilling system continues to advances, so the MPD automation must be also followed the technology trends

- **The application of a fully automated MPD delivers values to clients, drilling contractors, and service companies through enhancing operations above the performance possible by human**
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