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And special thanks to The American Institute of Mining, Metallurgical,
and Petroleum Engineers (AIME) for their contribution to the program.
Drilling with Casing:

What it Can and Can't Do for an Asset

Tommy Warren
Tesco Corp.
Tulsa
From Richard Spears –
2005 - 2006 SPE Distinguished Lecture

10 technologies to invest in this decade

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What is it?
How can it help you?
Drilling with Casing - A DEFINITION

Process for simultaneously drilling and casing a well where:

- the well casing is used for the drillstring.
- the casing is rotated as needed to drill.
- the casing is cemented in well at TD.
Drilling with casing has old roots, but has only recently become practical because of more robust tools.

Spindletop discovery well drilled with 10” casing!

Benefits of casing drilling were understood very early.

1926 patent – Retrievable & re-runnable casing bit.

- Eliminates drillpipe.
- Reduces trip time.
- Reduces crew size.
- Reduces stuck pipe.
- Reduces overall drilling time.
- Reduces overall drilling cost.
- Keeps every foot drilled.
- Casing can be set deeper.
- Reduces accidents on rig.
- Requires fewer casing string.
System Defined 35 Years Ago

First Casing Drilling System

- Electric Top Drive
- Casing Drive Tool
- Wireline retrievable
- Underreamer
- Casing centralizers

Requirements understood, but the hardware just wasn’t available!

Brown Oil Tool 1971 patent
So what’s different now?

- Top drives - robust & common.
- Casing drive tools available.
- PDC cutters.
- Robust casing connections & accessories.
- Rig automation systems.
- Better drilling fluid systems.
- Downhole tool designs.
- Directional tools.
- Increased economic incentive.
- Service company support.
Casing Drilling Systems Types

- **Non-Retrievable system**
  - Simplest and most commonly used type
  - String rotation required
  - No directional trajectory change capability

- **Retrievable BHA system**
  - Motor or casing rotation
  - Multiple runs per section
  - Directional and straight hole drilling

- **Liner drilling systems**
  - All deep water applications
Casing Drilling Providers

• Weatherford DwC® system. Drillshoe™ bits.
• Hughes Christensen EZCase™ drilling shoe.
• Tesco CASING DRILLING® system.
• Operators’ “home grown” systems.
• Many service providers focusing on support.
Considerations for drilling with casing

**Equipment**
- Casing handling at surface.
- Protect casing while drilling.
- Downhole drilling tools.

**Engineering**
- Well planning
- Operational practices
Handling the Casing

- Protect threads
- Fast connections
- Safe pipe handling
- Quick rig-up
Mechanical Casing Protection

- Crimping area
- Casing coupling
- Wear Band
- TC hardfacing
- Thermoplastic centralizers
Non-Retrievable Casing Bits

- Carbide Cutters
- TSP Cutters
- PDC Cutters

Courtesy Weatherford
Retrievable System

Drilling assembly:

- Locked to casing.
- Extends below casing shoe.
- Capable of multiple runs.
- Often retrieved with braided cable.
- Reliability is critical.
Retrievable CwD Tools Can Be Used in Complex Wells

- Directional BHA Can Include Rotary Steerable Tools.
- Can include LWD.
- Wells to horizontal have been drilled.
Incentive to Drill with Casing

- Faster process.
- Reduces hole conditioning time.
- Reduces trouble time.
- Enables more difficult wells.

24% of time from spud to TD (Jan 2004 Offshore magazine)
Bohai Bay China – Faster Process

13-3/8” Surface Casing
Batch set, drilled ~800 ft
Saved 21 days, $1.5 million

Wells in order drilled

Time, hours

Rig Up
Cement
Drilling
Rig Down

Courtesy Weatherford
Low pressure thief zone

- Drilled conventionally to 7,400 ft.
- Ran 9-5/8” casing with drillable shoe, conventional float equipment, & crimp-on stabilization.
- Drilled through thief zone @ 20° Inc.
- Cemented while rotating casing.
- Drilled out shoe with rock bit.
- Results
  - No fluid losses
  - Maintained inclination
  - Saved liner and $800,000

Drillable Shoe Reduces Trouble Time

Steel Drillable Shoe

Stabilizer

Low pressure thief zone

Courtesy Hughes Christensen
CwD Improves Hole Quality

- Less fluid loss than with conventional drilling
- Allows lower mud weight

<table>
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<tr>
<th>Mud Weights (ppg)</th>
<th>Casing</th>
<th>Drill pipe</th>
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<tr>
<td>Casing</td>
<td>9.6</td>
<td>10.2</td>
</tr>
<tr>
<td>Casing</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Casing</td>
<td>10.1</td>
<td>10.9 – 11.0</td>
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</table>
CwD Minimizes Lost Circulation

Offset 1
- 9 5/8” Csg.
- 7” Csg.
- 5 1/2” Liner
- 3 1/2” Csg.

19 days — Spud to Cementing of Intermediate — 10 days

Offset 2
- 9 5/8” Csg.
- 7” Csg.
- 5 1/2” Liner
- 3 1/2” Csg.

Offset 3
- 9 5/8” Csg.
- 7” Csg.
- 4 1/2” Csg.
- 3 1/2” Csg.

CwD
- 9 5/8” Csg.
- 7” Csg.
- 4 1/2” Csg.
- 3 1/2” Csg.

200 - 300 sack balanced cement plug
Reduces Risks without Needing Liner

Over 130 similar wells drilled in South Texas.
Increased Production in Depleted Zones

- 37 wells in 2,000 & 2001 uneconomical
- Sands from 4,000 – 7,000 ft
- Reservoir pressure: 90 to 2,800 psi
- Lost 1000s barrels of mud per well
- 9-5/8” and 7” casing to 7,000 ft
- CwD focus on production enhancement

- Drilled 57 wells with casing.
- Drilling time cut in half.
- Doubled production rate.
- Doubled ultimate recovery.

500 psi
300 psi
2200 psi
600 psi
2800 psi
90 psi
Managed Pressure Casing Drilling

- Rotating Head + Appropriate gas buster and flare system
Shell CwD System Used in S. Texas

- UBD of Production Tubing Eliminates at Least One Liner
- 3-1/2” x 2-7/8” tubing string with disposable bit
- Cost Reduced 30% & Reserves Added

Intermixed Pressures in One Interval

- Drilled w/13.5 ppg
- Drilled w/13.5 ppg

Shell: WOCWD-0431-05
Drilling with Casing Summary

- There’s an advantage!
- We now have the capability!
- Are there applications in your assets?
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