Improved methods, technology & best practices create savings in composite plug milling operations

William Handy – Applications Engineering Manager, Baker Hughes
October 24th, 2013
Definition of Problems

• Stuck Coil
  – Large Debris
  – Low Annular Velocity

• Slow Progress
  – Washing Sand
  – Slow Mill Times

• Extra Trips
  – Short Trips
    • Hole Cleaning
  – Long Trips
    • BHA replacement
    • Cutting Coil
Definition of Problems

- Stuck Coil
  - Large Debris
  - Low Annular Velocity

- Slow Progress
  - Washing Sand
  - Slow Mill Times

- Extra Trips
  - Short Trips
    - Hole Cleaning
  - Long Trips
    - BHA replacement
    - Cutting Coil
Definition of Problems

- Stuck Coil
  - Large Debris
  - Low Annular Velocity
- Slow Progress
  - Washing Sand
  - Slow Mill Times
- Extra Trips
  - Short Trips
    - Hole Cleaning
  - Long Trips
    - BHA replacement
    - Cutting Coil

Solutions

- Mill Design
Definition of Problems

- **Stuck Coil**
  - Large Debris
  - Low Annular Velocity
- **Slow Progress**
  - Washing Sand
  - Slow Mill Times
- **Extra Trips**
  - Short Trips
    - Hole Cleaning
  - Long Trips
    - BHA replacement
    - Cutting Coil

Solutions

- **Mill Design**
- **Application Specific Carbide**
Definition of Problems

- Stuck Coil
  - Large Debris
  - Low Annular Velocity
- Slow Progress
  - Washing Sand
  - Slow Mill Times
- Extra Trips
  - Short Trips
    - Hole Cleaning
  - Long Trips
    - BHA replacement
    - Cutting Coil

Solutions

- Mill Design
- Application Specific Carbide
- High Flow Motors
Definition of Problems

• Stuck Coil
  – Large Debris
  – Low Annular Velocity
• Slow Progress
  – Washing Sand
  – Slow Mill Times
• Extra Trips
  – Short Trips
    • Hole Cleaning
  – Long Trips
    • BHA replacement
    • Cutting Coil

Solutions

• Mill Design
• Application Specific Carbide
• High Flow Motors
• Milling Parameters
Definition of Problems

• Stuck Coil
  – Large Debris
  – Low Annular Velocity
• Slow Progress
  – Washing Sand
  – Slow Mill Times
• Extra Trips
  – Short Trips
    • Hole Cleaning
  – Long Trips
    • BHA replacement
    • Cutting Coil

Solutions

• Mill Design
• Application Specific Carbide
• High Flow Motors
• Milling Parameters
• Plug Design
Section 1

MILL DESIGN
Mill Design
Mill Design
Mill Design

Circulation

Sand
Section 2

APPLICATION SPECIFIC CARBIDE
Application Specific Carbide

• Optimizing Metallurgy & Form Factor Yields:
  – Increased Durability
  – Increased Rate of Penetration
  – Decreased Cuttings Size
Carbide Metallurgy

**Tough & Durable**

- Junk Milling
- Composite Plug Milling
- Casing Exit String Mill

**Hard & Sharp**

- Pilot Milling
- Packer Milling
- Casing Exit Window Mill
Case History

- **79 plugs** milled with one mill
  - Two wells
  - Williston, ND
    - Bakken Formation
  - 3-3/4” Mill
  - 2-7/8” Motor
Section 3
OTHER CONSIDERATIONS
Workover Motors

- High Flow Rate 2-7/8” Motors
  - Higher Annular Velocities
  - More Power
  - Decreased Durability

- 3”+ Motors
  - Higher Annular Velocities
  - More Power
  - Increased Durability & Strength
  - Transportation and Handling Issues
Milling Parameters

Cuttings Size

Milling Speed
Plug Design

- Hidden Slip Features
- All Cast Iron is NOT Created Equal
  - Cast Iron Type A: 1 min./in$^3$
  - Cast Iron Type B: 7 min./in$^3$

- Ceramic Buttons
  - Very Little Material
  - Very High Hardness

- Aluminum
QUESTIONS

THANK YOU