HDD MUD SCHOOL

HDD Fluid Basics to Cover

- HDD Drilling requirements
- Features of an HDD drilling fluid
- Functions of an HDD drilling fluid
- Properties of an HDD drilling fluid and testing procedures
- Why change the properties of a drilling fluid?
- HDD Drilling Fluids products
- Fluid Mixing Flow Chart

Drilling Requirements

- Thrust
- Rotation
- Energy (Hydraulic)

Drilling Fluid Features

We require a drilling fluid that includes the following features

- Optimises the five critical functions
- Enhances productivity
- Is environmentally safe for use

Five Critical Functions

1. Remove cuttings from the hole
2. Lubricate and cool the bit and drilling assembly
3. Stabilize the formation
4. Suspend drilled cuttings during static periods
5. Transmit hydraulic energy to the bit

Solids Volume Calculation

- Solids Generated during Pilot (L/m) =

$$\frac{(\text{Pilot Diameter (inches)})^2}{2}$$

- Solids Generated during back ream (L/m) =

$$\frac{(\text{Ream Diameter})^2 - (\text{Previous Diameter})^2}{2}$$

Fluid Pumping and Preventing Frac-outs Parameters:

* 5 inch (127 mm) diameter pilot
* solids volume = 12.5 L/meter
* Maintaining 20 % solids in flow stream

	38 LPM	95 LPM	189 LPM	284 LPM
3 meter Drill pipe	5 minutes	2 minutes	1 minute	40 seconds
4.6 meter Drill pipe	7.5 minutes	3 minutes	1.5 minutes	1 minute

Fluid Pumping and Preventing Frac-outs Parameters:

* 12 inch (305 mm) diameter back ream
* hole volume = 72 L/meter
* ream solids volume = 59.5 L/meter
* Maintaining 20 % solids in flow stream

	38 LPM	95 LPM	189 LPM	284 LPM
3 meter drill pipe	25 minutes	10 minutes	5 minutes	3.5 minutes
4.6 meter drill pipe	38 minutes	15 minutes	7.5 minutes	5 minutes

Initial Mud Volume Calculations

Bore Length (m)	100	
	Diameter	Volume (litres)
Pilot Hole (mm)	127	6,249.98
1st Ream (mm)	250	17,968.73
2nd Ream (mm)	350	23,249.95
3rd Ream (mm)	0	0.00
4th Ream (mm)	0	0.00
Total Volume Required		47,468.66 Litres
		47.47 M^3

Bentonite	23	1091.78 Kg	1.09 Tons
PHPA	3	142.41 Litres	0.14 M^3
PAC	1.2	56.96 Kg	0.06 Tons
Lubricant	5	237.34 Litres	0.24 M^3

Five Critical Functions
1 Hole Cleaning

Using the Proper Fluid will prevent:

- Slow drilling penetration rates
- Excessive torque and drag
- Stuck pipe
- Annular pack-off
- Lost circulation

Five Critical Functions
2. LUBRICATE AND COOL

Using the proper fluid will prevent:

- Increased torque and drag
- Premature bit failure
- Slow drilling rate
- Equipment stress
- Damage to Electronic Transmitter

Five Critical Functions
3. STABILIZE THE FORMATION

Using the correct fluid will prevent:

- Hole collapse
- Clay swelling
- Bit balling and mud rings
- Excessive solids

Five Critical Functions
4. SUSPEND THE CUTTINGS

Using the proper fluid will prevent:

- Bridging
- Stuck pipe
- Development of cutting beds in horizontal and high angle holes
- Increased torque and drag

Five Critical Functions
5. TRANSMIT HYDRAULIC ENERGY

Using the proper fluid prevents:

- Slow drilling rates
- Less power at the bit
- Poor hole cleaning

Hole Cleaning Video

Properties of Drilling Fluids

- Viscosity - thickness
- Density - weight
- Solids content - amount of solids

  SC (%) = (Mud weight – 1.0 (weight water)) / 1.6
- Flow characteristics - dynamic & static
- Chemical characteristics - i.e. pH level, hardness, etc.
- Filtrate loss & filter cake characteristics

Properties of Drilling Fluid

Properties can be:

- Measured
- Reported
- Changed by Chemical, Dilution with Water or Mechanical Means

Measured Properties of Drilling Fluids

- pH testing
- Marsh Funnel Viscosity
- Mud Weight (density of fluid)
- Sand content analysis
- Hardness/chlorides determination

Why change the properties of a drilling fluid?

- To optimize one or more of the five critical functions
- To eliminate or reduce drilling problems
- To increase productivity

Why Do We Need Additives?

- There is no universal fluid that works in all soil conditions
- We have to make compromises
- We have to control the fluid properties

Drilling Fluid Products

- **Soda Ash -** pH and hardness control in makeup water
- **High Yield** (i.e.. Max Gel) **-** viscosifier, gel strength, filter cake
- **One-Sack (** i.e.. Maxbore-HDD**) -** viscosifier, gel strength, filter Cake, reduced water loss, increased lubricity, and water conditioner

Drilling Fluid Products (cont'd)

- **PHPA's** (i.e..Poly-Plus Products) **-** clay inhibition, encapsulation, viscosity and lubricity
- **PAC's** (i.e.. Polypac Products) **-** fluid loss control, promote thin and firm filter cake, and increase viscosity
- **Rheology modifiers (i.e..Duo-Vis/Drilplex-HDD) -** increase the suspension ability of fluid (gel strength), and viscosity

Drilling Fluid Products (cont'd)

- **Thinners/Dispersants** (i.e..Ringfree) **-** break down clays to reduce problems associated with swelling and sticky clays
- **Lubricants** (i.e.. Rod Ease) **-** lubricates, reduces torque, corrosion protection and scale reduction
- **Detergent -** wetting agent to prevent clay from sticking to the pipe

Why Use a One-Sack Product?

- **One Sack** that contains pH control and polymeric additives for better lubricity and fluid loss control
- **One Sack** works well in challenging drilling environments (i.e. sugar sand/cobble/gravel)
- Where space and mobility are a problem**, One Sack** products eliminate the need to transport additives from site to site

Soil Types

- **Sand** - unconsolidated formation requiring good cuttings suspension and lubrication
- **Clay** - consolidated formation requiring swelling inhibition and lubrication
- **Rock** - consolidated or unconsolidated formation requiring good cuttings suspension and lubricity

Troubleshooting : Sandy Formations

- Sandy formations can vary in cohesion but are generally fairly loose and require special fluid considerations
- Bentonite concentrations should be higher in sand for good hole cleaning and PAC/CMC polymers should be used to ensure filtrate does not intrude and loosen formation (tight filter cake)
- Lubricants should be used as sand is fairly abrasive

Troubleshooting – Cobbles and Gravel

Troubleshooting - Clays

- Clays have varying degrees of reactivity and stickiness and special drilling fluids must be considered
- PHPA polymers act to inhibit clay swelling and lubricate sticky formations
- Dispersants are used to dissolve intruding and sticky clays
- PAC/CMC for fluid loss control

Troubleshooting : Hard Rock

- Rate of Penetration (ROP) is dependent on compressive strength of the formation
- Bentonite and polymers are used for hole cleaning and lubricants are used to reduce friction
- PAC/CMC polymers should be used with higher bentonite concentrations when fractured formations are encountered

Drilling Fluids Summary

- Test the “Make-Up” water for pH before building your mud
- Initial recommended dosages are required to treat formation transitions when “spudding-in”
- Product usage may be increased or decreased depending on drilling problems and/or ground conditions
- Specialty additives may be used to reduce or eliminate drilling problems

Questions

THANK YOU