Fundamentals of Drilling Engineering

Conversions and Constants

<table>
<thead>
<tr>
<th>Conversion</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ft = 0.3048 m</td>
<td></td>
</tr>
<tr>
<td>1 mPa∙s = 0.001 Pa∙s</td>
<td></td>
</tr>
<tr>
<td>1 K = 273.15°C</td>
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</tbody>
</table>

Casing Design

Recommended Clearing Ratio

\[ \text{Clearance between tube center in large tube} = \frac{0.13 \text{ in}}{\text{in}} \]

Recommended Mud Window

Equivalent Mud Density

\[ \rho_m = \frac{\rho_c}{1 + 0.03 \frac{H}{d}} \]

Common Bit Settings

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>4 1/2</td>
<td>6.65, 6.6</td>
</tr>
<tr>
<td>5 5/8</td>
<td>7.75, 7.75</td>
</tr>
<tr>
<td>6 1/4</td>
<td>8.88, 8.88</td>
</tr>
<tr>
<td>7 1/2</td>
<td>9.98, 9.98</td>
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<td>11.25, 11.25</td>
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<tr>
<td>10</td>
<td>12.14, 12.14</td>
</tr>
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<td>11 1/4</td>
<td>13.70, 13.70</td>
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<td>15.70, 15.70</td>
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<td>20.36, 20.36</td>
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Rig Power Requirements

Hoisting Power

\[ P_{hoist} = \frac{Q}{S_n} \]

Rotating Power

\[ P_{rot} = \frac{f \times T}{2978} \]

Water Pumping Power

\[ P_{w} = \frac{Q \times H}{745.6 \times 10^3} \]

Plastics Single Acting Pumps

\[ Q = 0.804 \left( \frac{d}{10} \right)^2 \frac{H}{10} \]


d = pump diameter \[ \text{in} \]

\[ H = \text{lifting head} \]

Drill Rig Capacity

Capacity and Volume

\[ V = \frac{Q}{density} \]

\[ Q = \frac{W}{density} \]

Water Volume

\[ V_w = \frac{Q_w}{27.13} \]

Casing Design

Casing Design

\[ C = 0.316 \frac{W}{D} \]

Rig Mud Window and Casing Point Selection

Equivalent Mud Density

\[ \rho_m = \frac{\rho_c}{1 + 0.03 \frac{H}{d}} \]

Drill Rig Capacity

\[ C = 0.316 \frac{W}{D} \]

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Well Control

Kinds of Kick

\[ A = \frac{Q}{27.13} \]

\[ V = \frac{Q}{27.13} \]

Number of Pump Strokes

\[ V_A = \frac{V}{3.6} \]

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Flow Control

- \( \Delta \) = friction factor
- \( L \) = internal diameter [m]
- \( t \) = thickness [m]
- \( D_o \) = outer diameter [m]
- \( D_i \) = inner diameter [m]
- \( D \) = area across choke [m]
- \( C_o \) = constant pressure specific heat capacity [\( \text{kJ/kg} \cdot \text{K} \)]
- \( C_v \) = specific volume at constant pressure [\( \text{m}^3/	ext{kg} \)]
- \( \rho \) = fluid density [\( \text{kg/m}^3 \)]
- \( p \) = input pressure [psi]
- \( p_o \) = outlet pressure [psi]
- \( e \) = liquid rate [/psi] / [day]
- \( g \) = gas rate [/psi] / [day]
- \( f \) = fluid density [/psi] / [ft]

Flow Control

- \( D_i \) = choke diameter [m]
- \( a \) = upstream area of choke [ft]
- \( b \) = downstream area of choke [ft]
- \( D \) = area across choke [ft]
- \( C_o \) = constant pressure specific heat capacity [\( \text{kJ/kg} \cdot \text{K} \)]
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- \( e \) = liquid rate [/psi] / [day]
- \( g \) = gas rate [/psi] / [day]
- \( f \) = fluid density [/psi] / [ft]
- \( L \) = avg. flowing thickness [ft]

Pipe Flow

- \( C_p \) = total circumference of pipe [inch]
- \( D \) = average diameter of pipe [inch]
- \( F \) = pump intake [psi]
- \( P \) = pump pressure [psi]
- \( P_G \) = pump standing valve [psi]
- \( P_{1a} \) = bottom surface pressure [psi]
- \( P_{2a} \) = fluid pressure [psi]
- \( S \) = vertical stress at choke [psi]
- \( r \) = stress radius [psi]
- \( e = \text{pipe thickness} / \text{wall thickness} \)
- \( M \) = max. wall load [psi]
- \( R_M \) = max. wall load [psi]
- \( H \) = peak polished red load [psi]
- \( H \) = fluid weight [psi]
- \( W \) = dynamic load [psi]
- \( L \) = plunger length [ft]

Vertical Lift Performance

- \( VLP \) = vertical lift pressure
- \( \Delta VLP \) = vertical lift pressure change
- \( q_i \) = initial rate [bbl/day]
- \( D_i \) = initial diameter [bbl]
- \( r \) = reservoir radius [bbl]
- \( e \) = skin factor
- \( \rho \) = average reservoir pressure [psi]
- \( f_{m} \) = multiphase flow permeability [psi]
- \( k_w \) = water permeability [psi]
- \( k_o \) = oil permeability [psi]
- \( k_r \) = relative permeability [psi]
- \( n \) = skin factor
- \( r_w \) = water radius [bbl]
- \( r_o \) = oil radius [bbl]
- \( N_c \) = cumulative production

Artificial Lift

- \( P_{1a} \) = pump intake [psi]
- \( P \) = pump pressure [psi]
- \( P_G \) = pump standing valve [psi]
- \( S \) = vertical stress at choke [psi]
- \( r \) = stress radius [psi]

Packer Forces

- \( P \) = pressure
- \( D \) = diameter of pipe

Pipe Flow

- \( P \) = pump intake [psi]
- \( P \) = pump pressure [psi]
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Pipe Flow

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