Directional Calculations for iPhone and iPod touch

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Directional Calculations
Applied to oil wells

Version: 2.0
Directional Calculations

Disclaimer

These tools and materials are provided 'as is' without warranties of any kind, express or implied.

Please verify the tools provided by this application by yourself before you use them. Ensure you understand the impact of using these tools.

Any use you choose to make of these tools & materials is undertaken by you entirely at you own risk.

Note:

This app was created with an educational proposal to help students and teachers of drilling engineering and has no intention of replace the professional software provided by directional companies. It is also an useful tool for other professionals in the oilfield, such as technicals and engineers.

Thanks
**Directional Terms**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>KOP</td>
<td>Kick Off Point</td>
</tr>
<tr>
<td>BUR</td>
<td>Build Up Rate</td>
</tr>
<tr>
<td>DOR</td>
<td>Drop Off Rate</td>
</tr>
<tr>
<td>DLS</td>
<td>Dog leg Severity</td>
</tr>
<tr>
<td>RC</td>
<td>Radius of Curvature</td>
</tr>
<tr>
<td>INC</td>
<td>Inclination, Drift</td>
</tr>
<tr>
<td>TVD</td>
<td>True Vertical Depth</td>
</tr>
<tr>
<td>MD</td>
<td>Measured Depth</td>
</tr>
<tr>
<td>VS</td>
<td>Vertical Section</td>
</tr>
<tr>
<td>CL</td>
<td>Course Length = MD2 - MD1</td>
</tr>
<tr>
<td>N/S</td>
<td>North / South coordinate</td>
</tr>
<tr>
<td>E/W</td>
<td>East / West coordinate</td>
</tr>
<tr>
<td>TR</td>
<td>Turn Rate</td>
</tr>
<tr>
<td>HD</td>
<td>Horizontal Displacement</td>
</tr>
<tr>
<td>CD</td>
<td>Closure Distance (= HD)</td>
</tr>
<tr>
<td>AZI</td>
<td>Azimuth</td>
</tr>
</tbody>
</table>

[Diagram showing directional calculations for iPhone]
Informations on the app

Version 2.0

Directional Calculations app provides useful tool to students, drillers, technicians, drilling engineers and other professionals of directional drilling.

- Calculates the survey parameters between two stations using the five methods (tangential, tangential balanced, minimum curvature, radius of curvature and average angle)
- Calculates the parameters of the 2D wells (types I, II and horizontal)
- Calculates the 3D projections (changing of the inclination and azimuth between stations)
- Calculates the projection of the Horizontal Displacement (Closure Distance) on the target azimuth

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How To

iCloud:
- Enabled if iCloud available on device
- Auto saves to restore when open again.
- Shares the same data on devices (iPhone, iPod Touch and iPad)
- Tap on button to get data edited on the other device

2D Wells:
- Tap on titles to edit values (Kop, BUR,...)
- Edit parameters from Top to Bottom
- Touch and swipe to right for [< Back]

3D Section Calculations:
- First, Select a option to edit parameters: BUR/INC and TR/AZI.
- Check for informations on [info button).
- With the Minimum Curvature Method
Use this tool to calculate wells without changing the azimuth. Use the templates for Well Type I, II and Horizontal.

1. Select the Length Unit: Meter or Foot
2. Click on Well Type button on Main Menu
3. Edit parameters from top to bottom
Well Type I - Build and Hold

Example

1. Start a build up 2.0 deg/100ft at 7,600 ft
2. Stop build up to inclination = 30 deg
3. Hold until Target at 12,000 ft / 120 deg

Tap on titles to edit parameters

1. Select Length Unit = FOOT
2. Set KOP = 7600
3. Set BUR = 2
4. Set INC = 30
5. Set Azimuth = 120
6. Set MD = 12000
Well Type II - Build-Hold-Drop-Hold

Example

1. Start a build up 2.0 deg/100ft at 7,600 ft
2. Stop build up to inclination = 30 deg
3. Hold until 12,000 ft @ direction 240 deg
4. Drop inclination to 10 deg @ 2.5 deg/100 ft
5. Hold until Target at 14,000 ft

1. Select Length Unit = FOOT
2. Set KOP = 7600
3. Set BUR = 2
4. Set INC = 30
5. Set Slant MD = 12000
6. Set DOR = -2.5
7. Set Final INC = 10
8. Set MD = 14000
9. Set Azimuth = 240
Example

1. Start a build up 3.0 deg/100ft at 7,600 ft
2. Stop build up to inclination = 90 deg
3. Hold until Target at 12,000 ft / 330 deg

1. Select Length Unit = FOOT
2. Set KOP = 7600
3. Set BUR = 3
4. Set MD = 12000
5. Set Azimuth = 330
Calculations between two survey stations

1) **TANGENTIAL:**
\[ \Delta N/S = \Delta MD \times \sin(\theta_2) \times \cos(\theta_2) \]
\[ \Delta E/W = \Delta MD \times \sin(\theta_2) \times \sin(\theta_2) \]
\[ \Delta TVD = \Delta MD \times \cos(\theta_2) \]

**DOG LEG SEVERITY** (degree/100 ft)
\[ DLS = \frac{100 \times (MD \times |\sin(\theta_1)| \times |\sin(\theta_2)| \times |\sin(\theta_1) \times \cos(\theta_2)| + \cos(\theta_1) \times \cos(\theta_2))}{|\cos(\theta_1) \times \cos(\theta_2)|} \]

2) **BALANCED TANGENTIAL:**
\[ \Delta N/S = \Delta MD/2 \times |\sin(\theta_1) \times \cos(\theta_1) + \sin(\theta_2) \times \cos(\theta_2)| \]
\[ \Delta E/W = \Delta MD/2 \times |\sin(\theta_1) \times \sin(\theta_1) + \sin(\theta_2) \times \sin(\theta_2)| \]
\[ \Delta TVD = \Delta MD/2 \times |\cos(\theta_1) + \cos(\theta_2)| \]

3) **MINIMUM CURVATURE:**
\[ \Delta N/S = \Delta MD/2 \times |\sin(\theta_1) \times \cos(\theta_1) + \sin(\theta_2) \times \cos(\theta_2)| \times RF \]
\[ \Delta E/W = \Delta MD/2 \times |\sin(\theta_1) \times \sin(\theta_1) + \sin(\theta_2) \times \sin(\theta_2)| \times RF \]
\[ \Delta TVD = \Delta MD/2 \times |\cos(\theta_1) + \cos(\theta_2)| \times RF \]

\[ B = \text{acos}(\cos(\theta_2+\alpha) - |\sin(\theta_1)| \times |\sin(\theta_2)| \times (1 - \cos(\theta_2 - \alpha))) \]

\[ RF = 2/\theta \times \tan(B/2) \]

4) **RADIUS OF CURVATURE:**
\[ \Delta N/S = |\Delta MD \times (\cos(\theta_1) - \cos(\theta_2)) \times (\sin(A2) - \sin(A1))| / ((\theta_2 - \theta_1) \times (A2 - A1)) \]
\[ \Delta E/W = |\Delta MD \times (\cos(\theta_1) - \cos(\theta_2)) \times (\cos(A2) - \cos(A1))| / ((\theta_2 - \theta_1) \times (A2 - A1)) \]
\[ \Delta TVD = |\Delta MD/2 \times (\sin(\theta_2) - \sin(\theta_2))| / (\theta_2 - \theta_1) \]

Angles in radians. \(A(\text{deg}) \times \pi / 180 \Rightarrow \text{radian}\)

**DOG LEG SEVERITY** (degree/100 ft).
\[ DLS = \{\text{acos} \ [\cos(\theta_1) \times \cos(\theta_2) + |\sin(\theta_1) \times \sin(\theta_2) \times \cos(A2 - A1)|]\} \times (100 + MD) \]

5) **ANGLE AVERAGING:**
\[ \Delta N/S = \Delta MD \times |\sin(\theta_1 + \theta_2)/2| \times \cos(A_1 + A_2)/2 \]
\[ \Delta E/W = \Delta MD \times |\sin(\theta_1 + \theta_2)/2| \times \sin(A_1 + A_2)/2 \]
\[ \Delta TVD = \Delta MD \times \cos((\theta_1 + \theta_2)/2) \]

For All Methods:
\[ \Delta HD = \text{Square Root } [(\Delta N/S)^2 + (\Delta E/W)^2)] \]

Dog Leg Severity is calculated by method “Radius of Curvature” on methods 2, 3, 4 and 5.
Calculations between two survey stations

### Directional Calculations for iPhone

**Between two Stations**

<table>
<thead>
<tr>
<th>Terms</th>
<th># 1</th>
<th># 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD</td>
<td>7500 ft</td>
<td>7600 ft</td>
</tr>
<tr>
<td>Inclination</td>
<td>10 deg</td>
<td>13 deg</td>
</tr>
<tr>
<td>Azimuth</td>
<td>50 deg</td>
<td>45 deg</td>
</tr>
<tr>
<td>Bearing</td>
<td>N 50.00 E</td>
<td>N 45.00 E</td>
</tr>
<tr>
<td><strong>CL, ft</strong></td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td>ΔTVD ft</td>
<td>97.44</td>
<td>22.50</td>
</tr>
<tr>
<td>ΔHD ft</td>
<td>19.92</td>
<td>19.93</td>
</tr>
<tr>
<td>ΔN/S ft</td>
<td>15.91</td>
<td>15.91</td>
</tr>
<tr>
<td>ΔE/W ft</td>
<td>14.60</td>
<td>14.69</td>
</tr>
<tr>
<td>Tangential</td>
<td>97.96</td>
<td>19.93</td>
</tr>
<tr>
<td>Balanced Tangential</td>
<td>97.98</td>
<td>19.94</td>
</tr>
<tr>
<td>Minimum Curvature</td>
<td></td>
<td>13.47</td>
</tr>
<tr>
<td>Radius of Curvature</td>
<td></td>
<td>13.46</td>
</tr>
<tr>
<td>Average Angle</td>
<td></td>
<td>13.47</td>
</tr>
<tr>
<td>DLS (deg/100ft)</td>
<td>3.16</td>
<td></td>
</tr>
<tr>
<td>BUR (deg/100ft)</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>TR (deg/100ft)</td>
<td>-5.00</td>
<td></td>
</tr>
</tbody>
</table>
3D Well Section Calculations

Parameters for example

Set the Previous Parameters
1. MD = 6000 ft, TVD = 5906.26 ft
2. Inc = 0 deg, Azimuth = 26.00 deg
3. N/S = 698.88 ft, E/W = 340.87 ft

Set the 3D Well Section Parameters
1. Inc = 37 deg
2. Azimuth = 55 deg
3. DLS = 4 deg / 100 ft

Set the Target Azimuth to calculate the Vertical Section
1. Set Target Azimuth = 0 deg

Minimum Curvature Method
Set the Previous Parameters

1. MD = 6000 ft, TVD = 5906.26 ft
2. Inc = 0 deg, Azimuth = 26.00 deg
3. N/S = 698.88 ft, E/W = 340.87 ft

- Set the previous parameters.
- 3D Section: Tap on [i] button to instructions view.
- Set the target azimuth to calculate the closure distance projection on the vertical section.
- Calculations by Minimum Curvature Method.
Set the 3D Well Section Parameters

1. Inc = 37 deg
2. Azimuth = 55 deg
3. DLS = 4 deg / 100 ft

In this case, select options to set angles INC and AZI.
3D Well Section Calculations

Set the Target Azimuth to calculate the Vertical Section:

- Projection of the closure distance on the target azimuth

\[ VS = CD \times \cos (az,\text{target} - az,\text{cd}) \]

1. Set Target Azimuth = 0 deg
### 3D Well Section Calculations

#### Calculation Tool - Help

**Select an option:**

<table>
<thead>
<tr>
<th>BUR, MD</th>
<th>INC</th>
<th>MD, BUR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set BUR, MD -&gt; INC</strong></td>
<td><strong>Set INC, MD -&gt; BUR</strong></td>
<td></td>
</tr>
</tbody>
</table>

1. **Editing "BUR"**
   - Gets value in "MD" -> Calculates "INC"

2. **Editing "MD"**
   - Gets value in "BUR" -> Calculates "INC"

3. **Editing "INC"**
   - Gets value in "BUR" -> Calculates "MD"

<table>
<thead>
<tr>
<th>TR, MD</th>
<th>AZI</th>
<th>TR, MD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set TR, MD -&gt; AZI</strong></td>
<td><strong>Set AZI, MD -&gt; TR</strong></td>
<td></td>
</tr>
</tbody>
</table>

1. **Editing "TR"**
   - Gets value in "MD" -> Calculates "AZI"

2. **Editing "MD"**
   - Gets value in "TR" -> Calculates "AZI"

3. **Editing "AZI"**
   - Gets value in "TR" -> Calculates "MD"

**Built in formulas:**

- BUR -> Build Up Rate
- TR -> Turn Rate
- INC -> Inclination
- AZI -> Azimuth
- MD -> Measured Depth
Set the Target Azimuth to calculate the Vertical Section:

- Projection of the closure distance on the target azimuth

\[ VS = CD \times \cos(\text{az, target} - \text{az, cd}) \]
About

This app was developed based on our experience. There is no comparison with any other software.

Our goal was to create a low-cost application with the help of experts to share with drilling engineers, technicians, drillers, students and teachers of drilling engineering.

There is no intention to replace the professional softwares.

You can contribute with suggestions for improvements, correcting the translation to english, reporting bugs and spreading it to your friends.

Please visit our support url and see other applications for Oil & Gas for iPhone, iPod Touch, iPhone and Mac.