Selection of perforation technique for brown fields: A novel approach
Outline

**Case Study / Economy**

**Selection of perforation technique for brown fields: A novel approach**
Pressure across production system

Big Picture .....
**Influence of Perforation on Darcy Flow Equation**

Where we stand ......

\[
Q_o = \frac{0.00708 \ k \ h \ (\bar{p}_r - pwf)}{\mu_o \ B_0 \ [\ln \frac{r_e}{r_w}] - 0.75 + SKIN_{Total}}
\]

\[
PI = \frac{Q_o}{\bar{p}_r - pwf} \propto \left( \frac{1}{SKIN_{Damage} + SKIN_{Perforation}} \right)
\]

\[
SKIN_{Perforation} = f \left( \begin{array}{c}
\text{Penetration} \\
\text{Diameter} \\
\text{Efficiency}
\end{array} \right) = f \left( \begin{array}{c}
\text{Formation Geomechanics} \\
\text{Explosive type, weight} \\
\text{Liner type, shape} \\
\text{Crushed zone, Flow area}
\end{array} \right)
\]

\[
\text{Crushed zone & Flow area} = f \left( \begin{array}{c}
\text{Overbalanced} \\
\text{Static Underbalanced} \\
\text{Dynamic Underbalanced}
\end{array} \right)
\]

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Types of Perforation Tunnels

Penetration > Damage Zone

Path A

\[ \Delta P_A = \Delta P_{\text{Crushed Zone}} \]

Path of least resistance

Penetration < Damage Zone

Path B

\[ \Delta P_B = \Delta P_{\text{Damage}} + \Delta P_{\text{Crushed Zone}} \]
Flow Area

Another way to look at skin...

$A_{OH} > A_{PERF}$

$A_{OH} < A_{PERF}$

$A_{OH} = 2\pi r w h$

$A_{PERF} = n \pi r p \sqrt{l_p^2 + r_p^2}$

$A_{PERF} = n \{ \pi r p \sqrt{l_p^2 + r_p^2} - (r_d + r_p) l_d - \pi r t \sqrt{l_t^2 + r_t^2} \}$

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Sensitivity Analysis

- SPF should increase with the increase of hole size to achieve larger flow area

Big gun for big hole but what about SPF??

\[ A_{PERF} = \frac{A_{OH}}{spf} \]

- Skin causes more pressure loss to low k reservoir
- Skin makes more meaning with permeability

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Case Study: Production Well

**Initial Plan**
- 500 psi **overbalanced** perforation with W/L
- Perform hydraulic frac job
- Run DST to evaluate zone

**Modified Plan**
- 700 psi **underbalanced** perforation by TCP + DST string
- Perform flow study

Skin = -0.6  
Perm = 3 mD

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Case Study: Exploration Well

Pressure Derivative Plot

Zone-III: 700 psi Underbalanced Perf. (TCP)
MDT Mobility: ~4 mD/cP
Skin: -0.3

Zone-II: 500 psi Overbalanced Perf. (W/L)
MDT Mobility: ~9 mD/cP
Skin: + 8

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Perforation Economics

Have you considered Skin into the economics?

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Conclusion

- Perforation plays a vital role in production
- Lack of knowledge / ignorance are two major factors behind inefficient perforations
- The cost of inefficient perforation is huge
- Each perforation job is unique and needs extensive planning
- Selection of perforation technique should be in favour of reservoir health

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QUESTIONS?
THANK YOU!