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Module 10
PERFORATING APPLICATIONS

CONTENT

- *Perforating for cement squeeze*
- *Perforating for hydraulic fracturing*
- *Perforating for sand control completions*
- *Perforating for sand management*
- *Perforating water injectors*

PERFORATING APPLICATIONS

Different well and reservoir requirements might require different perforating methods and gun design. Two(2) key issues are always critical; well productivity and safety of the operations. Other considerations include

- Gun orientation for hydraulic fracturing, frack & pack and sand management
- Perforating density for water injectors and sand control completions
- Depth control for multilayer reservoirs
- Charge penetration for competent or unconsolidated reservoir rocks

PERFORATING APPLICATIONS – CEMENT SQUEEZE

Main considerations include:

- Entry hole diameter
- Depth control
- Phasing
- Penetration

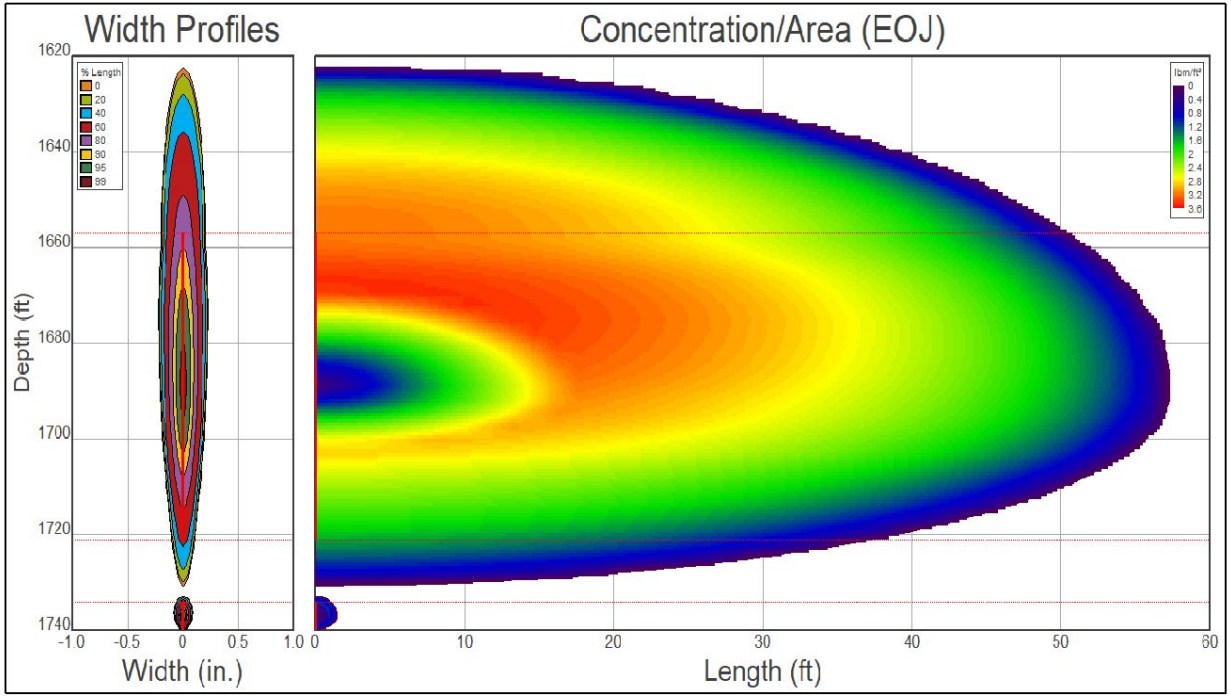
PARAMETER	IMPORTANCE	GUIDELINE
Entry hole diameter	Medium	
Length	High	For maximum flow area exposed
Density	High	4 < SPF < 8
Phasing	High	30° < phase < 120° for max. circumferential coverage
Orientation	Low	No applicable
Charges	Medium	Important to achieve good penetration
Method	High	Wireline conveyed is the preferred if possible
Fluids	High	Existing hydrocarbons or clean workover fluid
Pressure	Medium	Underbalance or near balance are preferred

PERFORATING APPLICATIONS – HYDRAULIC FRACTURING

Hydraulic fracturing is the opening of a conductive flow path in a rock with low porosity and permeability

Main considerations include

- Entry hole diameter
- Depth control
- Orientation
- Casing integrity



PERFORATING APPLICATIONS – HYDRAULIC FRACTURING (Continued)

Main considerations include

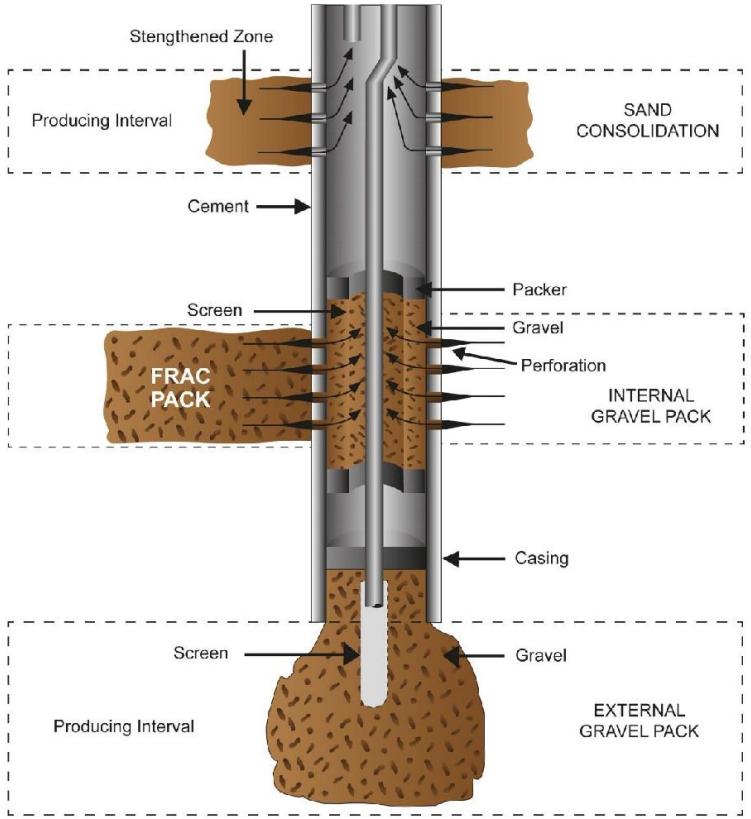
- Entry hole diameter
- Depth control
- Orientation
- Casing integrity

PARAMETER	IMPORTANCE	GUIDELINE
Entry hole diameter	High	Larger hole diameter if possible, it increases friction pressures if too small
Length	Low	Formation will be fractured so all what is needed is some penetration into the rock
Density	Medium	Depending on the flow rate, normally < 8 spf
Phasing	High	180 ° , 90 °
Orientation	High	Shots in the direction of fracture propagation to avoid the tortuosity effect
Charges	Low	Sufficient to allow a short tunnel to be generated
Method	High	Wireline conveyed for satisfactory depth control
Fluids	Medium	Clean workover fluid
Pressure conditions	Low	Near balance
Main concern	Control of fracture growth, direction and orientation, casing integrity	

PERFORATING APPLICATIONS - SAND CONTROL

There are four (4) main sand control methods that require perforating, all have specific requirements

1. Internal gravel packs – Shot density and penetration
2. Frack & packs – Orientation and shot density
3. Stand-alone-screens in cased holes – Penetration and shot density
4. Sand consolidation – Shot density, entry hole diameter and fluids

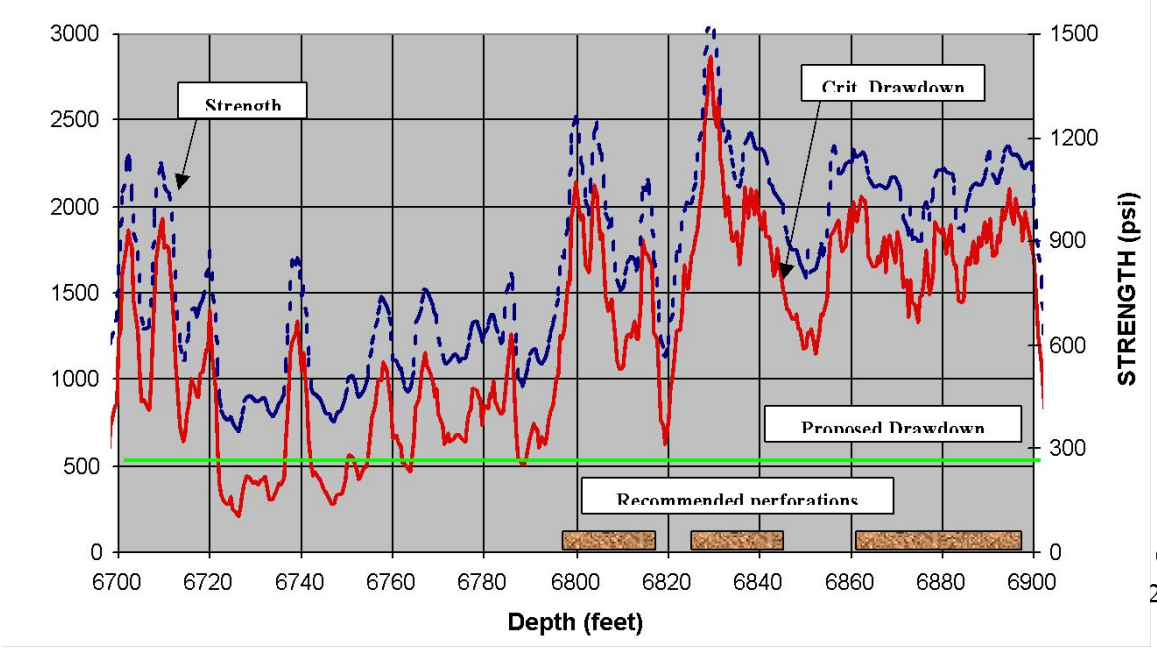


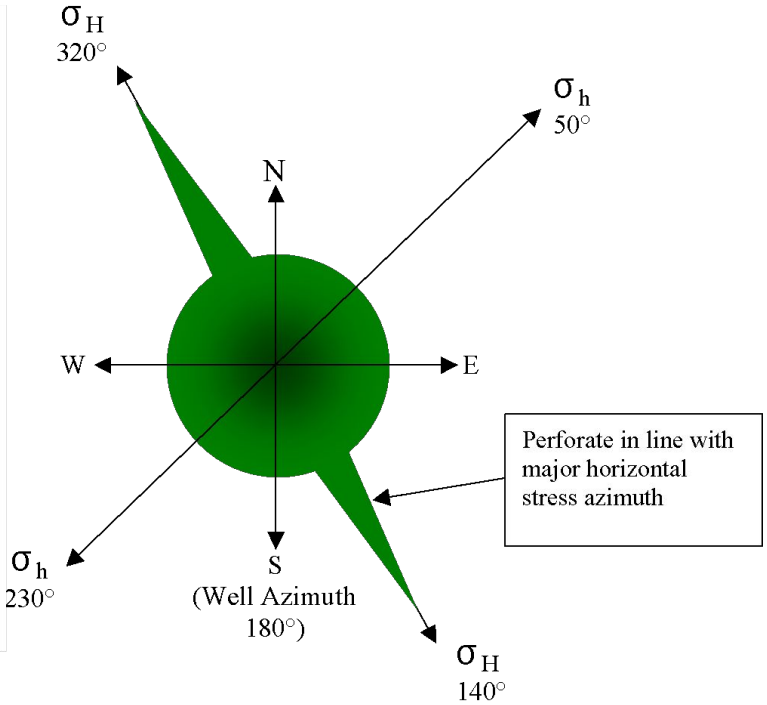
PERFORATING APPLICATIONS – SAND CONTROL (Frac & Pack)

PARAMETER	IMPORTANCE	GUIDELINE
Entry hole diameter	Medium	Sufficient to minimize friction losses
Length	Low	-
Density	Medium	4 < SPF < 6
Phasing	High	30° < phase < 120° for max. circumferential coverage
Orientation	Low	Not very important because K is high
Charges	Low	-
Method	High	Done w/TCPs for cost reasons but wireline is preferred
Fluids	Medium	Clean workover fluid
Pressure Conditions	Low	Near balance is satisfactory
Main concern	Avoid vertical fracture growth and ensure tip screen out.	

PERFORATING APPLICATIONS – SAND MANAGEMENET

Wells on sand management can be completed with selected or oriented perforations





PERFORATING APPLICATIONS – WATER INJECTORS

The main considerations in this case are

- Penetration
- Density
- Casing integrity
- Entry hole diameter

PARAMETER	IMPORTANCE	GUIDELINE
Entry hole diameter	High	Larger hole diameter to minimize pressure losses
Length	Medium	Sufficient to establish good communication with the reservoir
Density	Medium	Very dependable on K, for ↑ K there is no need to perforate high density, 4 < spf < 12
Phasing	Medium	Depend on density and well orientation, design to ensure good radial distribution of flow
Orientation	Low	Depend on well azimuth and deviation
Charges	Low	Sufficient to establish communication with reservoir
Method	Medium	Wireline conveyed for satisfactory depth control
Fluids	Medium	Existing hydrocarbons, clean workover fluid
Pressure conditions	Medium	Mainly perforated overbalance
Main concern	Casing integrity and long term performance	

SUMMARY

The selection of a perforating method and gun system is in most cases specific to the application. As a result, each application requires the ranking of the method and gun performance suitable. Among those applications we have:

- Squeeze cementing – penetration, shot density and depth control
- Hydraulic fracturing - orientation, entry hole diameter and shot density
- Water injectors – shot density, entry hole diameter and charge penetration

- There are five(5) sand control methods that require perforating; stand-alone-screens, internal gravel packs, frack and pack, sand consolidation.

Sand management requires the use of a perforating method and gun type that minimize or mitigate the stress conditions around the tunnels therefore, selective or oriented perforating are often used.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