

# Squeeze Cementing

- Forces cement slurry, under pressure, through perforations or holes in the casing or liner.....
  - Used to permanently block entry of undesirable fluids to the wellbore or to fill channels behind the casing. Water production from watered out zones or leaks are common targets.
  - Also used to set “cement packers” to isolate sections of the annulus.
  - The cement plug must remain an effective seal full temperature, highest pressure and in contact with any fluid from the well.

# Repair Cementing

- Squeeze Cementing
  - Shutting off watered-out perforation intervals
  - Filling channels behind the pipe
  - Covering pipe annuli that was never cemented
  - Setting cement packers

# Treatment Execution

- Execution of squeeze cementing operations in four basic steps:
  - Wellbore preparation
  - Slurry mixing and pumping
  - Squeeze
  - Removal of excess cement

# Squeeze Cementing – channel repair

- Objectives
  1. Locate the channel
  2. Perforate into the channel
  3. Inject cement and fill the channel

## Problems

1. locating the channel
2. squeezing into the channel

# Channel Detection

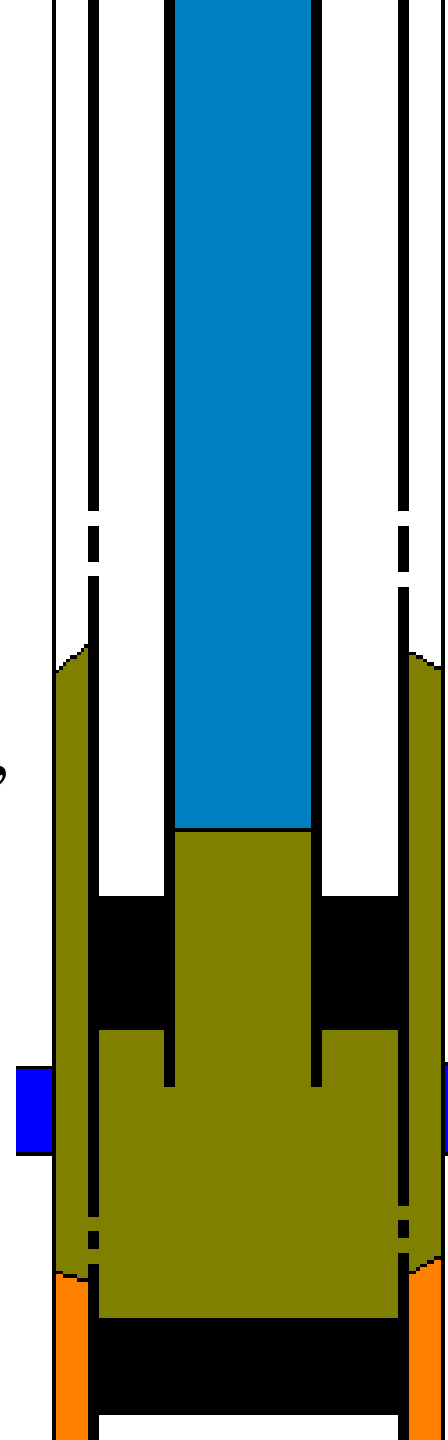
- Cement bond log
- Noise log? - leaks
- Segmented or radial bond log
  - Bond differences
  - Looking for patterns that represent channels
- Block perforate and squeeze techniques

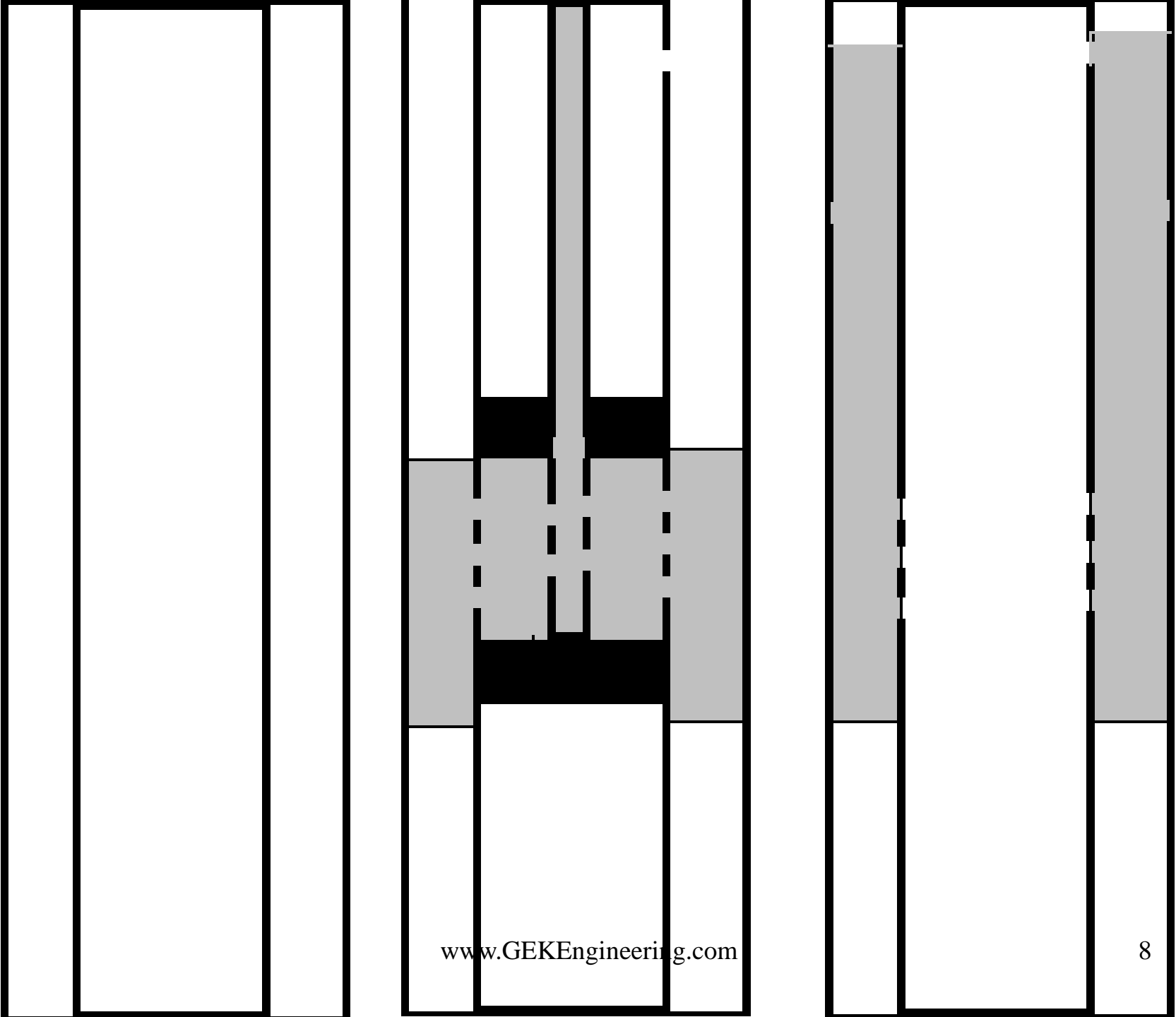
# Squeeze Types

- **Hesitation squeeze** – steady application of pressure thought by some to force cement in matrix – may only help build size of dehydrated mass or “node” through fluid loss of liquid from the cement slurry.
- Actually – what may be happening in some cases is that the wellbore is being “restressed” – forming a “stress cage” by solids from mud or cement wedging into and bridging on the formation. This may allow 1 to 5 lb/gal higher fluid gradient weight than initial frac pressure of the formation.

# Squeeze Types

- Suicide squeeze – This squeeze perforates two spots – high and low and squeezes from the bottom towards the top. There is a chance, if slurry volumes are too large, of cement spilling out of the upper perforations and sticking the isolation packer or retainer in the well.



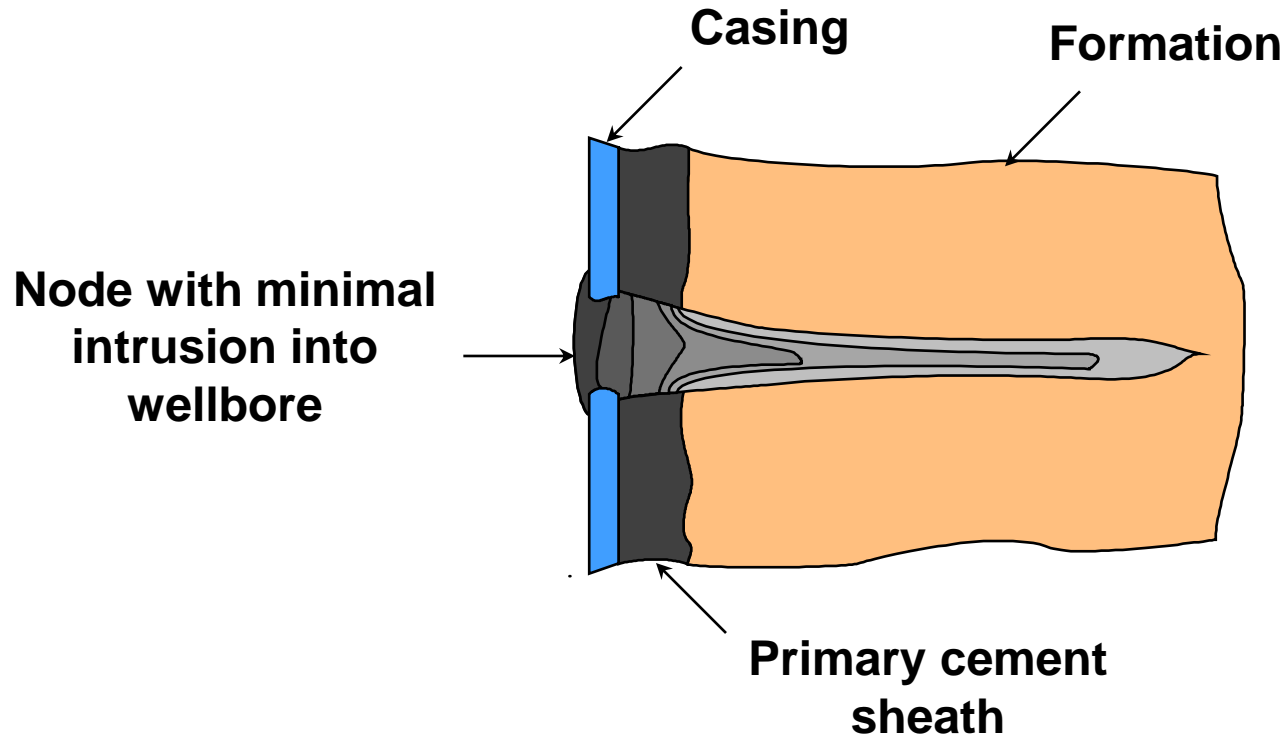




# Fluid Loss Control

- Excessive fluid loss in the slurry can result in bridging of tubulars by dehydrated cement.
- Slurries with too little fluid loss can result in insufficient buildup of filter cake on the formation (may also be a function of permeability and pressure).
- Fluid loss additives may be required to control fluid loss.

# Cement Node Buildup



# Rheology Controls

- Cement slurries have higher viscosity than most workover fluids and this significantly reduces maximum possible pump rate.
- Rheology and stability tests are commonly performed:
  - At surface mixing temperatures, and
  - At bottomhole static temperature BHST (caution – make sure mix water temperature is not higher than bottom hole temp.).
- Slurries must stable to provide good rheology characteristics that are easily reproducible.

# Slurry Volume

- Volume of slurry prepared depends on:
  - Length of perforated interval
  - Capacity of liner/casing or channel behind pipe
  - Void areas behind the perforations
  - Force that can be applied to the tubing
  - Configuration of surface mixing / pumping equipment
  - Use of cement plugs, pigs or darts (isolation devices)
- Previous squeeze experience provides best guidelines.

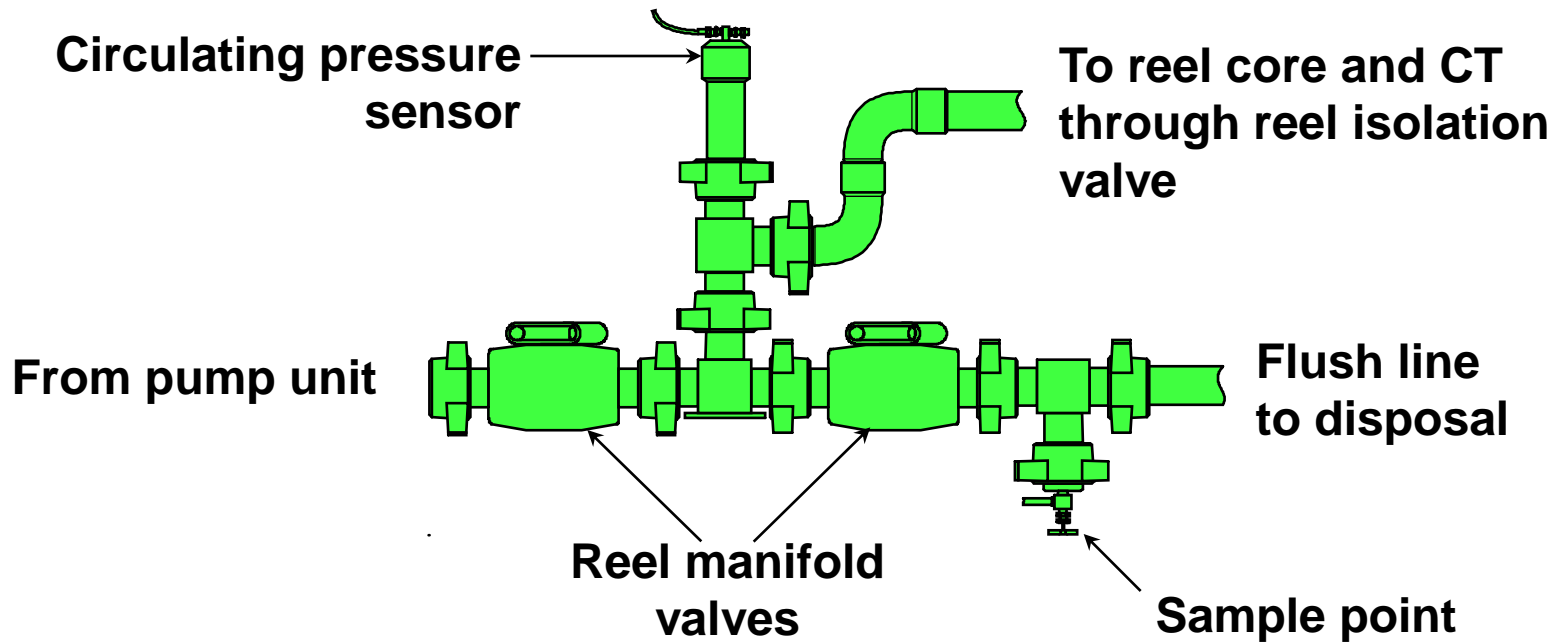
# Depth Control – (with CT)

- In cement squeezing, surface equipment not accurate enough to position CT nozzle
- Downhole reference point is generally required
- Methods of setting depth reference
  - Tagging bottom
    - inaccurate in wells with fill, but viable in certain conditions
  - Tagging completion restrictions
    - tubing end locator (TEL) or tubing nipple locators (TNL)
    - commonly used in squeeze cementing

# Cement Contamination Problems

- Contamination can result in:
  - Unpredictable slurry characteristics
  - Reduced compressive strength of the set cement
  - Incorrect placement due to change in slurry volume
- To avoid contamination:
  - Spacer fluid should isolate (ahead of/behind cement)
  - Lines should be flushed each time a new fluid is pumped
  - Mechanical separation of cement slurry using CT plugs (darts or pigs)

# Reel Manifold Sampling Point and Flush Line



# Cement Composition and Vol.

- Low or high fluid loss? Depends on depth
- Volume of cement? – depends on channel size
  - Often try several small squeezes.
  - Pressure?



# Squeeze Success?

- Usually about 50% - but conditions make success vary widely.
- Increases when:
  - circulation is possible through the channel,
  - Isolation is used fro cement injection,
  - cement blending is pod mix,
  - the operator is experienced.

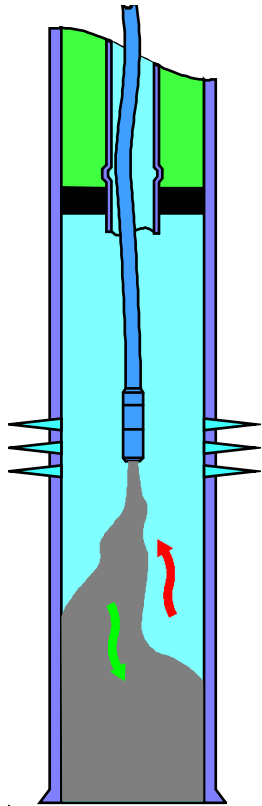
# Cement Packer

- Can isolate the annulus
  - Water control
  - Tubing repair or isolation
  - Stabilizing tubing prior to milling window
- Problems and considerations
  - Floating the cement in the annulus – there are ways!
  - How long a cement column? - 50 to 300+ feet.
  - Cement compositions for packers

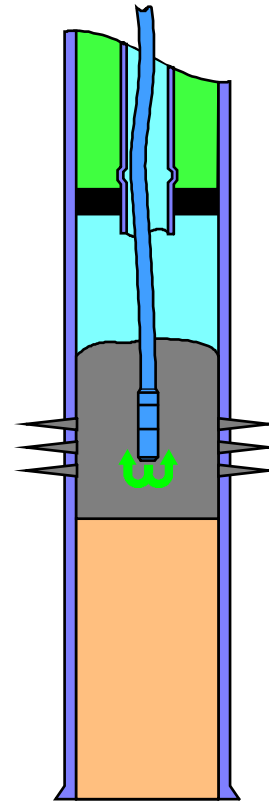
# Cement Packer

- Perforated annulus at or below point for packer.
- May need to perforate above top of packer when annulus is liquid filled.
- Displace cement from a straddle packer or packer and plug (or retainer) into the annulus.

# Cement Placement With and Without Retaining “Platform”



**Cement slurry falls through less dense fluids**



**Stable cement column placed over the platform**

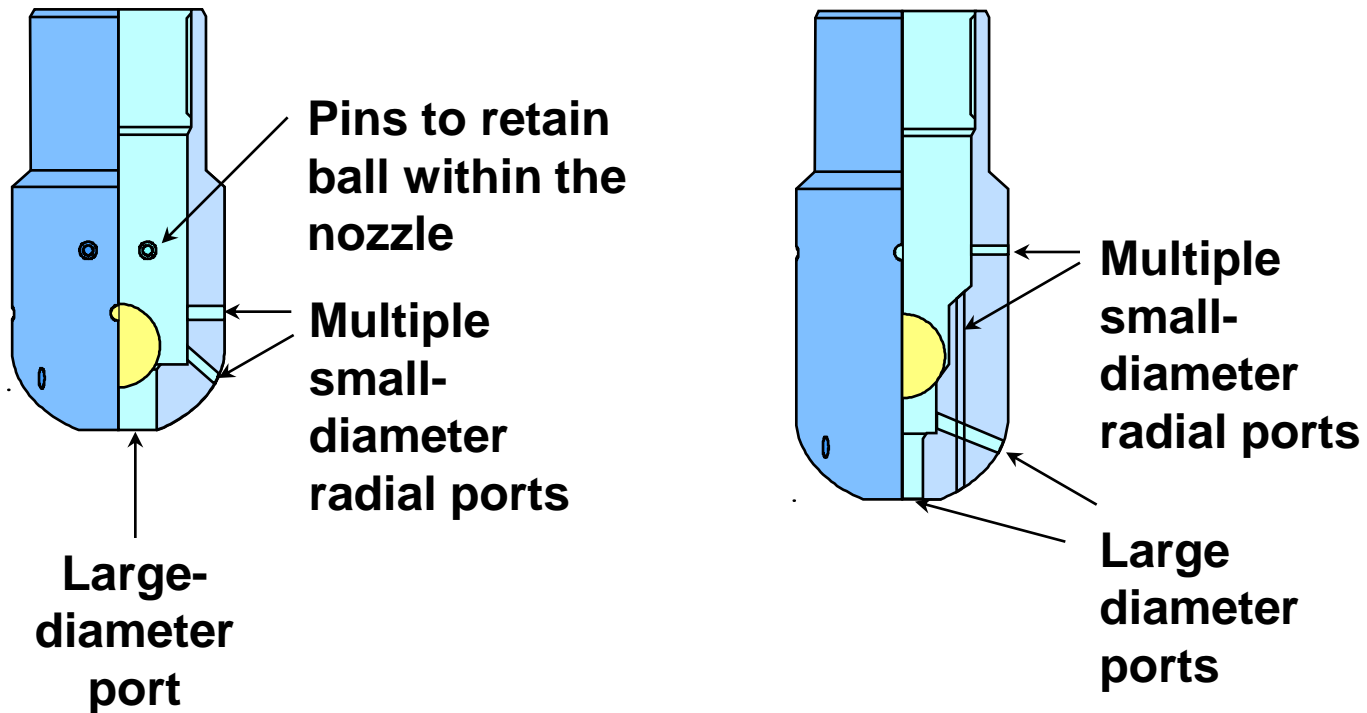
**Cement platform**

A retainer, mechanical plug, highly gelled mud pill (10 to 20 bbls) or a cement plug may be used as the “platform”.

# Tool Selection

- Tool strings should generally be kept to a minimum
  - Connector
    - required on all jobs
  - Check valves
    - cannot be used with reverse circulation of excess cement
  - Depth correlation
    - tubing end or nipple locators are commonly used
  - Plug catcher
    - catch and retrieve plugs ahead/behind cement slurry
  - Nozzles
    - developed to improve the slurry placement

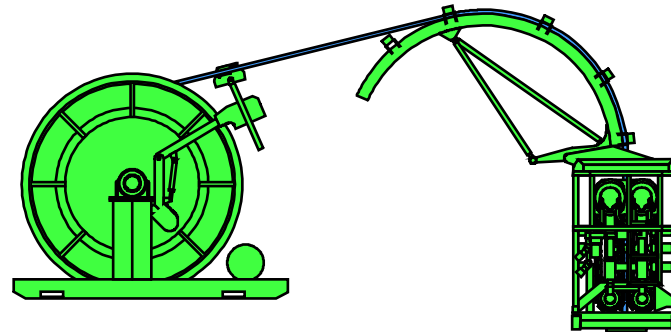
# Cementing Nozzle Features



# Monitoring Recording Parameters

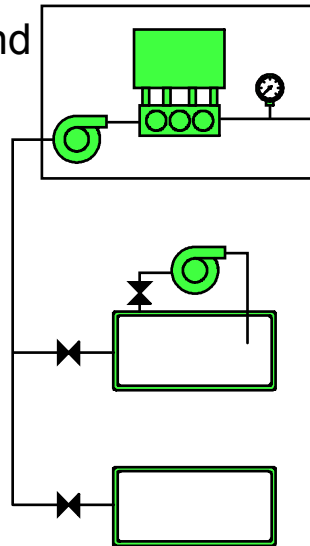
## Coiled tubing

- Pressure, rate/volume, string weight, depth and tubing OD and tubing cycles.



## Pump unit

- Pressure, density and pump rate/volume



## Slurry batch mixer

- Monitor density and volume

## Other tankage

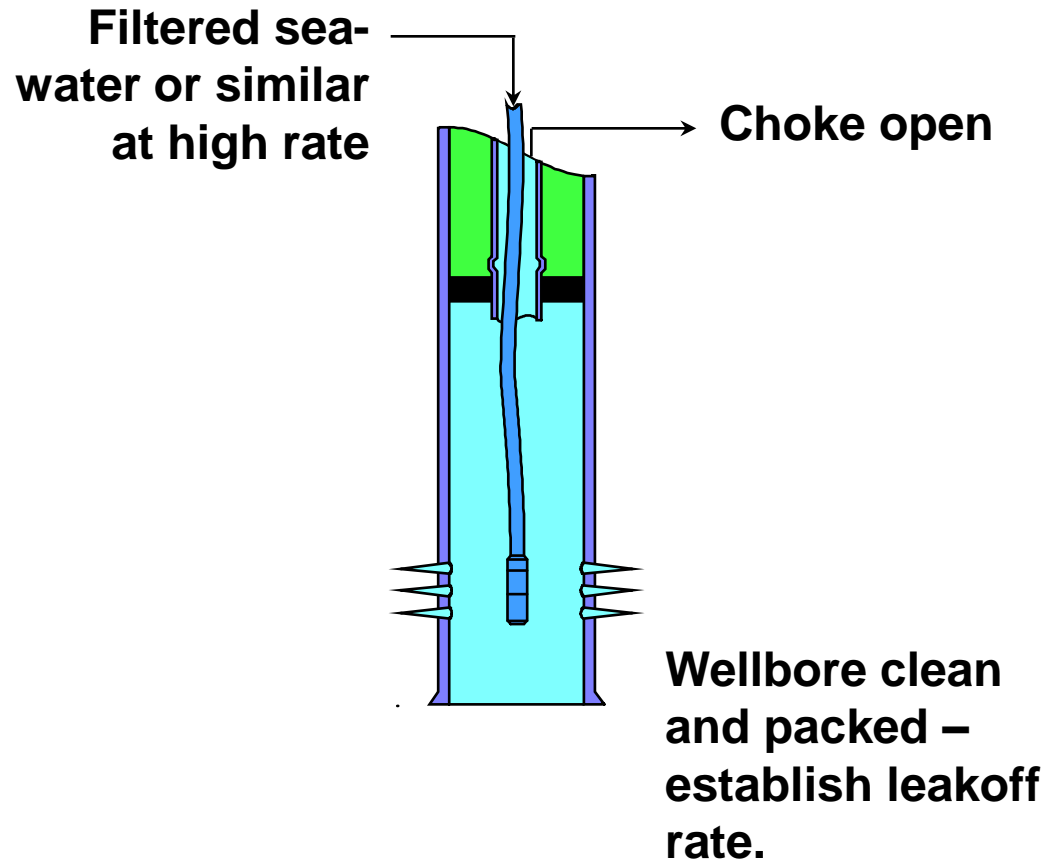
- Monitor density and volume



## Annulus

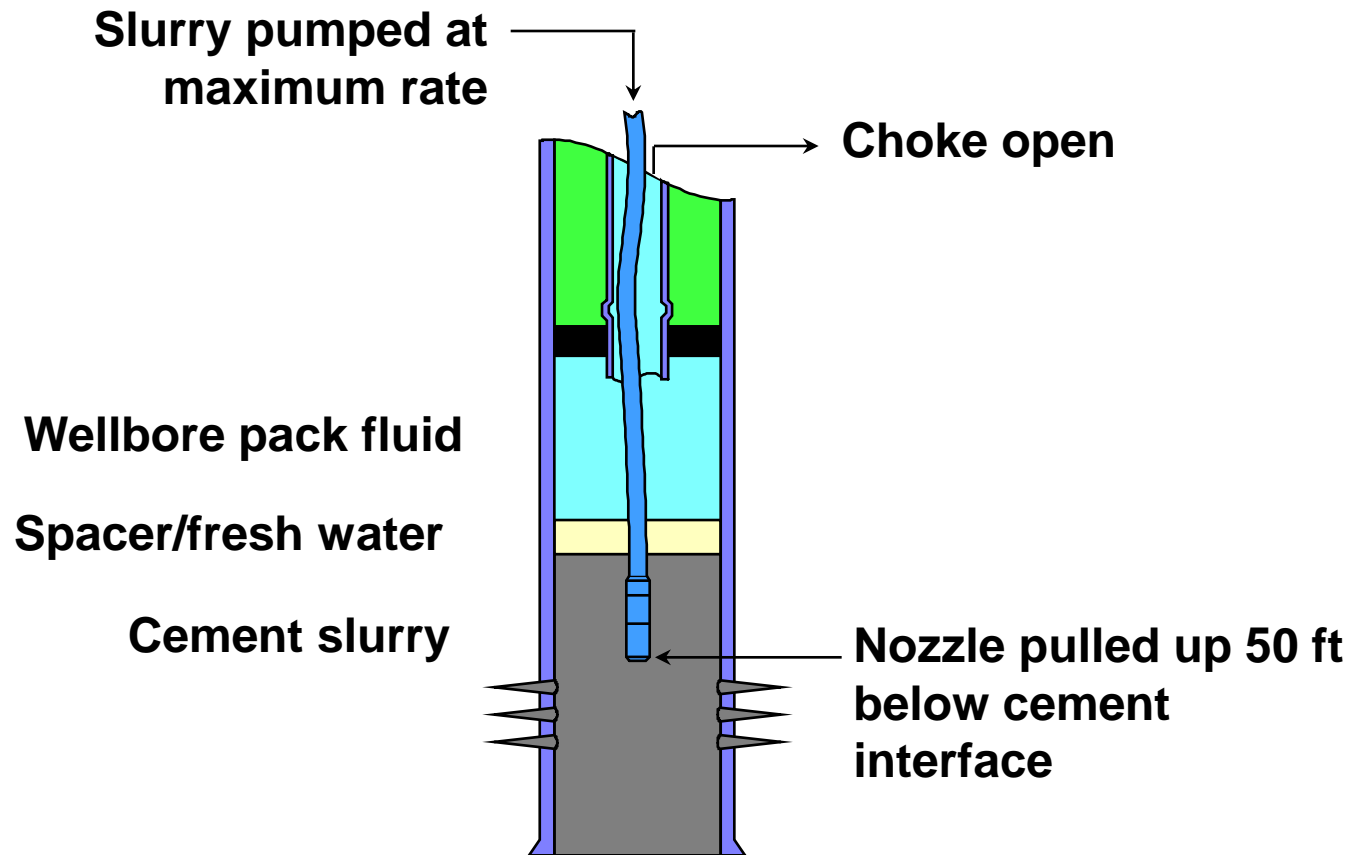
- Monitor volume and density of all fluids returned and pumped through the annulus.
- Record pressure.

# Wellbore Preparation



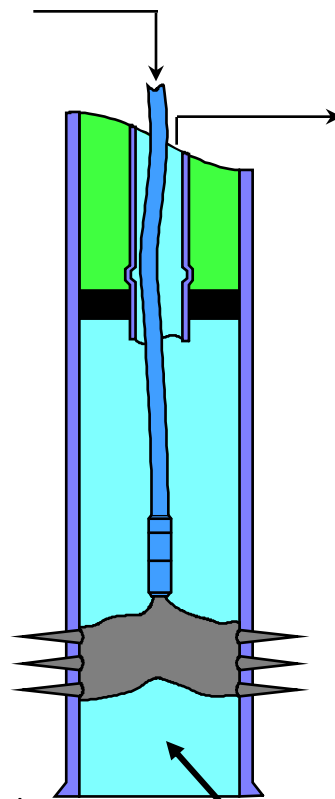


# Laying In Cement Slurry



# Placing Thixotropic Slurries

Slurry pumped at maximum rate/pressure allowed



Choke closed, if wellbore not fluid packed, pump slowly down annulus to prevent U-tubing

Wellbore pack fluid

Cement slurry

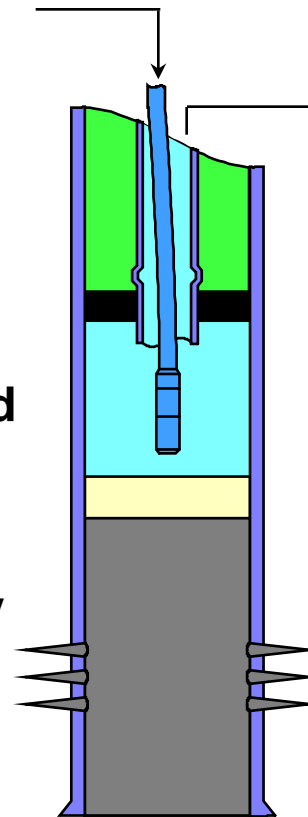
Wellbore pack fluid

Nozzle placed above thief zone

Highly gelled mud or other “platform” usually needed except in severe fluid loss.

# Commencing Squeeze

Low rate continuous  
pumping or hesitation



Choke back returns  
monitoring pressure  
and volumes

Wellbore pack fluid

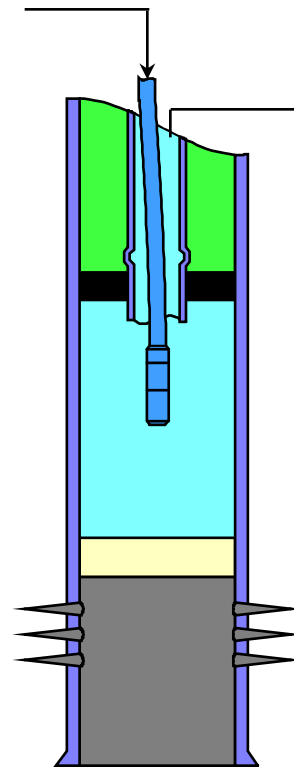
Spacer/fresh water

Cement slurry

Nozzle pulled up  
>50 ft above  
cement interface

# Completing Squeeze

Displacement fluid pumped  
at maximum rate/pressure  
allowed



Choke back returns  
increasing final squeeze  
pressure

Wellbore pack fluid

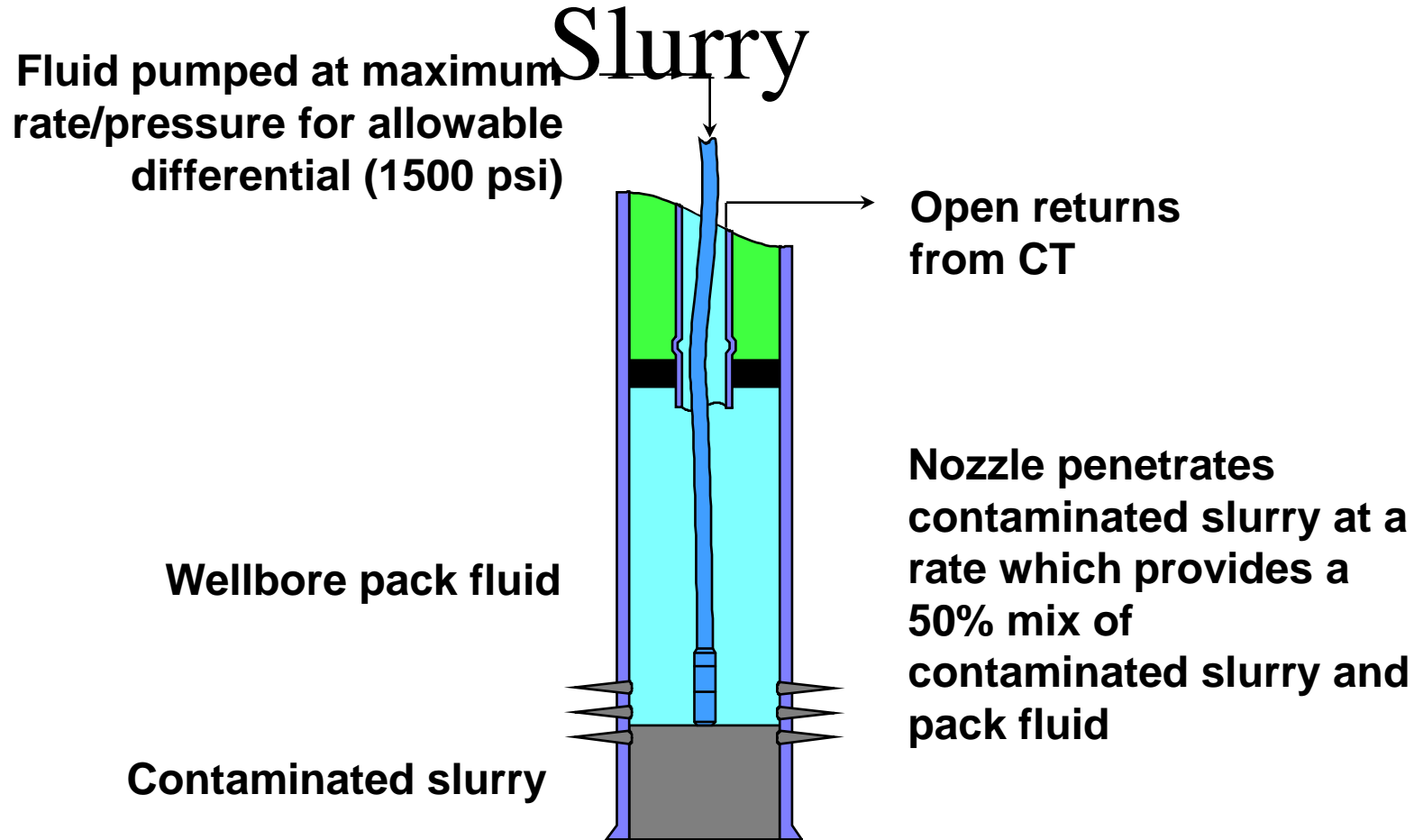
Spacer/fresh water

Cement slurry

Nozzle moved  
continuously or  
frequently



# Reverse Circulating Excess

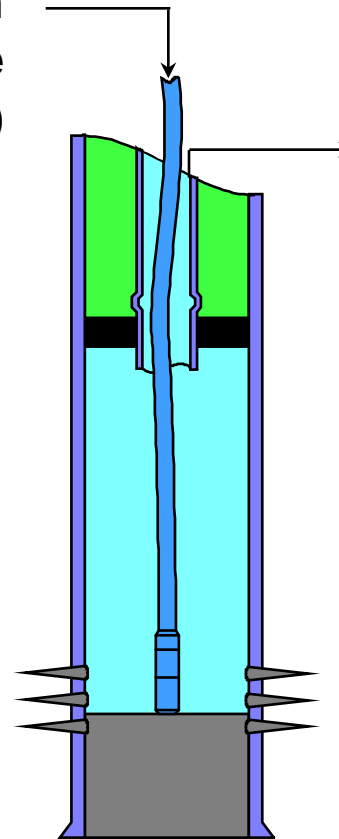


# Reverse Circulating Live Slurry

Fluid pumped at maximum rate/pressure for allowable differential (1500 psi)

Wellbore pack fluid

Cement slurry

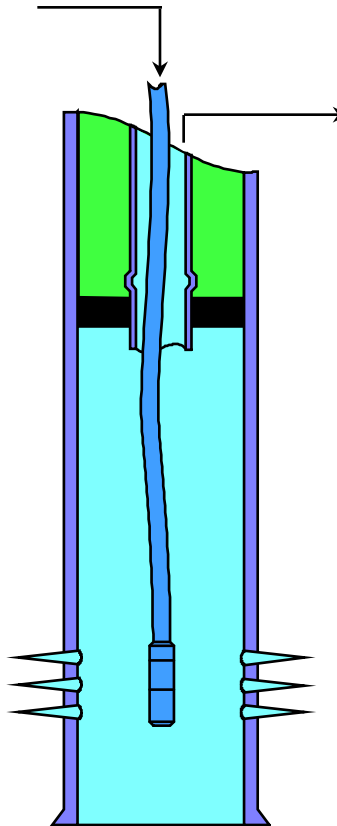


Open returns from CT

Nozzle penetrates slurry at a rate which provides a 50% mix

# Wellbore Circulated Clean

Fluid pumped at maximum rate/pressure



Returns choked to maintain pressure on squeezed zone

Wellbore pack fluid

Nozzle reciprocated through treatment zone to TD

Differential pressure maintained against squeezed zone



# Wellbore Preparation

- Wellbore preparation operations include
  - Slick-line work, e.g. fitting dummy gas-lift mandrels
  - Pressure test the production tubing annulus
  - Establish hang-up depth or TD using slick line
  - Confirm and correlate depths with CT and flag the tubing
  - Remove fill from rat hole below perforated interval
  - Perform pretreatment perforation wash or acidizing
  - Place a stable platform for cement slurry
  - Ensure wellbore fully loaded with filtered water (or equivalent)

# Slurry Mixing and Pumping

- Key points in the slurry mixing and pumping process include
  - Batch mix and shear the slurry
  - Conduct job-site quality control tests
  - Prepare contaminant and spacer fluids as required
  - Confirm CT depth
  - Lay in cement slurry following pumping schedule
- When using thixotropic cements
  - Do not stop pumping while cement is inside the work string
  - Place CT nozzle above thief zone and pump down production tubing/CT annulus while squeezing the cement
  - Overdisplace cement slurries out of the wellbore

# Squeeze

- Downhole generation of filter cake aided by performing hesitation type squeezes
  - For example, 10 min at 1000 psi, 15 min at 1500 psi, 20 min at 2000 psi...
- As fracture pressure exceeded
  - Filter cake prevents formation from fracturing

# Removal of Excess Cement

- Efficient removal of excess cement
  - Critical to timely completion of job
  
- Achieved using several methods:
  - Reverse circulation of live cement
  - Circulation of contaminated cement
  - Reverse circulation of contaminated cement

# Reverse Circulation of Live Cement

- Reverse circulation of live cement slurry can be performed if
  - Designed slurry thickening time (including safety factor) allows for completion of the reversing phase
  - CT penetration rate controlled to effectively dilute the slurry as it is removed
  - Maximum density of reversed fluid is 10 lb/gal
  - Reversing is continued until clean returns observed at surface

# Rev. Circulation of Contaminated Cement

- Contamination of excess cement is often necessary to:
  - Extend slurry thickening time
    - allows cleanout operations to be completed safely
  - Allow cleanout operations to be delayed until cement nodes have increased compressive strength

# Typical Cement Slurry Contaminant Composition

## • TYPICAL CEMENT SLURRY CONTAMINANT COMPOSITION

- **Borax/Bentonite**
- 10 to 20 lb/bbl Bentonite
- 20 lb/bbl Borax
- 3 gal Cement Retarder
- **Bio-Polymer Gel**
- 1.5 lb/bbl Biozan gel

# Circulation of Contaminated Cement

- Conventional circulation used when:
  - Operating conditions cannot safely support reverse circulation of excess slurry
- Example:
  - Operations performed through 1-1/4-in. work strings cannot employ reverse circulation techniques
  - Reason: excessive friction pressure encountered



# Evaluation of Squeeze

- Methods used to evaluate depend on treatment objectives
- Initial step in evaluation process
  - Confirm condition of wellbore in the treatment zone
- If wellbore is obstructed
  - Drilling/under-reaming may be required
- Additional check
  - Ensure the rat hole is debris or cement free