STIMULATION METHODS

Muhammad Umair ilyas
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• What is Well Stimulation?

• Why we do well stimulation?

• How can we do well stimulation?
What is Well Stimulation?

Opening up new channels in the rock for the oil and gas to flow through is called 
stimulation.
Why we do well stimulation?

- Sometime, petroleum exists in a formation but is unable to flow readily into the well because the formation has very low permeability.

- Formation damage around the wellbore caused by invasion of perforation fluid and charge debris.
How can we do well stimulation?

There are two main methods of well stimulation:
- Acidization
- Fracturing
• If the formation is composed of rocks that dissolve upon being contacted by acid, such as limestone or dolomite, then a technique known as acidizing may be required.

• Acidizing operation basically consists of pumping from fifty to thousands of gallons of acid down the well.
• Continued pumping forces the acid into the formation where it produces channels.

• Channels will provide a way for the formation’s oil or gas to enter the well through the perforations.
Acidization

Remove near wellbore damage by injecting acid / reacting fluid into the formation below fracturing pressure

Acid
Displacing fluid

Well

1-4 ft

Shale Reservoir

Acid pumper
Acids

The most common acid systems in use are:

1. Hydrochloric Acid:
   - Concentrations ranging between 7.5% and 28%, the most common is 15%.
   - It will dissolve Calcium Carbonate (CaCO3), Dolomite (CaMgCO3), Siderite (FeCO3), and Iron Oxide (Fe2O3).
Reactions

• $2\text{HCl} + \text{CaCO}_3 \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$  
  (Calcite)

• $4\text{HCl} + \text{CaMg(CO}_3)_2 \rightarrow \text{CaCl}_2 + \text{MgCl}_2 + 2\text{CO}_2 + 2\text{H}_2\text{O}$  
  (Dolomite)

• $2\text{HCl} + \text{FeCO}_3 \rightarrow \text{FeCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$  
  (Siderite)
2. Mud Acid:

- This is a mixture of HCl and HF (hydrofluoric acid) and is generally 12% HCl and 3% HF.

- It will dissolve clay materials in the formation, along with feldspars and quartz.

- The HF will react with Na, K, Ca and Si in the clays to form insoluble precipitates, so it is advisable to always preflood with HCl.
Reactions

• $4HF + SiO_2 \leftrightarrow SiF_4 + 2H_2O$ (Silicon tetrafluoride)

• $SiF_4 + 2HF \leftrightarrow H_2SiF_6$ (Fluosilicic acid)

• $Al_2Si_4O_{10}(OH)_2 + 36HF \rightarrow 4H_2SiF_6 + 12H_2O + H_3AlF_6$
3. Organic Acids:
These are Acetic and Formic Acids. They are slower acting than HCl, and are generally used in high temperature wells and wells with high alloy tubing to reduce corrosion rates.
4. EDTA:
This is Ethylene Diamine Tetra-Acetic Acid. It dissolves carbonates and sulphates by chelating them. It is more expensive than the other acids and the reaction is slower.
ACID ADDITIVES

- Corrosion inhibitor
- Surfactant
- Non-Emulsifier
- Anti Sludge Agent
- Iron Controller
- Mutual Solvent
- Friction Reducer
- Clay Stabilizer
- Diverting Agent
Corrosion inhibitor

Factors Affecting Corrosion During an Acid Treatment

- Temperature
- Contact Time
- Acid Concentration
- Metal Type

Benzalkonium chloride
Surfactant

- Can act to:
  - Change surface and interfacial tensions.
  - Disperse clays and fines.
  - Change or maintain the wettability of reservoir.
- Non Emulsifier

- Contains water soluble group (polymer)
- Temperature sensitive.

More versatile & results in
- Prevention of emulsion formation
- Lowered surface tension
- **Anti Sludge agent**

  ✓ “Sludge” is a precipitate formed from reaction of high strength acid with crude oil.

  Methods of sludge prevention:
  ✓ Solvent (Xylene, Toluene) pre-flush to minimize physical contact.
  ✓ Use of low strength acid.
Iron Controller

- Sequestering agents or Chelating agents are used to eliminate water hardness and heavy metals, such as iron and copper.

Methods of Iron Control:
- Chelating (iron chemically bound) e.g. Acetic acid, Citric acid.
- Sequestering (iron retained in solution) e.g. EDTA.
- **Mutual Solvent**

  ✓ Controlling the wettability of contact surfaces before, during or after a treatment, and preventing or breaking emulsions.

  ✓ A commonly used mutual solvent is “ethylene glycol monobutyl ether”, generally known as EGMBE.
Clay Stabilizer

- To keep clays and fines in suspension and to prevent migration and swelling of clays

- Normal treating concentrations normally up to 1% (V/V)
Diverting Agents

✓ A chemical agent used in stimulation treatments to ensure uniform injection over the area to be treated.

✓ By creating a temporary blocking effect that is safely cleaned up following the treatment, enabling enhanced productivity throughout the treated interval.

✓ Benzoic acid is used as a chemical diverter.
Acidization steps in general

- **Pre-flush Stage (5% - 10% HCl)**
  - 50 to 100 gal/ft of formation in general.
  - To remove carbonates.
  - To push NaCl or KCl away from wellbore.

- **Acid Stage**
  - HF to dissolve clay / sand.
  - HCl to dissolve carbonates.
After-flush stage
(10% Ethylene Glycol Monobutyl Ether – EGMBE)

- To make the formation water wet.
- To displace acid away from wellbore.

- After an acid job is performed, the used acid and sediments removed from the reservoir are washed out of the well in a process called backflush.
Fracturing

• Hydraulic fracturing is the most common mechanism for increasing well productivity.

• In certain carbonate reservoirs fracturing is performed with acid.

• In other carbonate and sandstone reservoirs propped fracturing is used.
Why Fracture?

• By-pass near wellbore damage

• Increase well production by changing flow regime from radial to linear

• Increase access to the reservoir from the well bore
Purpose of Fracturing

Blocked permeability

After Fracturing
• We can recover more volume of oil by using fracturing.
Radial Flow Regime

• By its nature, radial flow is inefficient
Effect of Hydraulic Fracture on Flow Regime

- If properly created, hydraulic fractures can change flow regime from radial to linear.
Characteristics of major fluid system

- **Water base:**
  - Gelled water: medium viscosity, low friction
  - Cross linked water gel: high viscosity, high proppant carrying capacity, low friction loss carrying
- **Oil base:**
  Compatible with reservoir, high viscosity, high friction loss

- **Emulsion base:**
  Good viscosity, low fluid loss, good clean up

- **Acid base:**
  Low viscosity, unstable at high temperature
Fracturing Operation
Hydraulic Fracturing: Stages

• There is a range of hydraulic fracturing techniques and several different approaches may be applied within a specific area.

1. Spearhead stage: Also referred to as an acid stage. This serves to clear debris that may be present in the wellbore providing a clear pathway for fracture fluids to access the formation.
2. **Pad stage**: A batch of carrying fluid without proppant that is used to break the formation and initiate the hydraulic fracturing of the target formation.

3. **Proppant stage**: During this stage a mixture of water and sand (i.e. proppant) is fed into the wellbore. Thus, maintaining the enhanced permeability created by the hydraulic fracture program.
4. **Flush stage**: A volume of fresh water is pumped down the wellbore to flush out any excess proppant that may be present in the wellbore.
Hydraulic fracturing in general

- Pumping a special blended fluid down the well and into the formation under great pressure.

- Pumping continues until the downhole pressure exceeding fracture pressure of the rocks

- Meanwhile, sand or aluminum pellets are mixed into the fracturing fluid. These materials are called proppants.
Proppants remain in the fractures when pumping is stopped.

Since the fractures try to close back together after the pressure on the well is released, the proppant is needed to hold fractures open.

These propped-open fractures is permeable enough to provide passages for oil or gas to flow into the well.
Thank you