

Fluids



Learning Objectives

- ◆ You will learn about different fluids that can be used in well control.
- ◆ You will become familiar with the characteristics and limitations of fluids.
- ◆ You will learn general safety precautions when handling these fluids.

Overview

- ◆ Most operations rely on liquid fluids.
- ◆ The fundamentals of fluid control are vital to well control.
- ◆ There are eight general functions of fluids:
 1. Transportation of cuttings to surface.
 2. Suspension of cuttings when circulation is stopped.
 3. Control of annular pressure.
 4. Lubrication and cooling of the bit/string.
 5. Wall support.
 6. Suspension of string and casing.
 7. Deliver hydraulic energy.
 8. Provides a suitable medium for wireline logging.

- ◆ Specific use fluids have additional desirable properties:
 - Completion fluids are used opposite the production zone and are designed to prevent unwanted formation damage.
 - Packer fluids are left between the tubing and casing above the packer. These fluids must be stable, non-corrosive, maintain pressure control and remain able to be circulated.

Fluid Uses



- Drilling
- Side Tracking
- Deepening
- Plugging back
- Cleaning out
- Well killing
- Acidizing
- Fracturing
- Cementing
- Perforating
- Recompletion
- Packer fluid
- Completion fluid
- Circulating
- Stimulating

Side Effects of Fluids

- ◆ There are side effects that should be minimized:
 - Open hole formation damage – Can happen in the form of hydrocarbon production or wellbore stability. Some formations are more sensitive to different fluids than others and may require special drilling fluids or chemical treatments to minimize formation damage.
 - Casing and drillstring corrosion – Protection to casing and string is accomplished by treating the surface of the steel or by chemical additives to the fluid.

Side Effects of Fluids

- Penetration rate reduction – A reduction in penetration rate will occur if the hydrostatic pressure of the fluid is greater than the formation pressure.
- Circulation, surge and swab problems – High viscosity limits the flow rate, places an extra stress on the pump, and may also reduce penetration rates. Thick filter cake can affect surge and swab pressure that may cause a kick.
- Lost circulation – If hydrostatic pressure exceeds formation strength, fluid losses and formation breakdown may occur.

Side Effects of Fluids

- ♦ String sticking – A thick filter cake and excessive amount of cuttings are two factors in pipe sticking. Stuck pipe greatly increases the cost of the well.
- ♦ Wellbore erosion – Hole erosion causes problems with wireline logging, cementing, and pipe sticking. There are two types of wellbore erosion:
 - Physical erosion - Physical erosion can be reduced by using lower pump rates.
 - Chemical erosion - Depends on how the fluid and formation chemically react with one another.

Side Effects of Fluids

- ♦ Settling in the pits – Solids in the fluid can settle in pits. Gel strength can prevent unwanted solids from dropping in the pits. Gravity, along with the help of de-sanders, de-silters, centrifuges and mud cleaners all assist in the removal of solids.
- ♦ Mud pump wear – Solids, such as sand or metal, can cause extreme pump wear. Sand is the most abrasive solid and should be controlled by proper use of screens and solids control equipment.
- ♦ Cement and environmental contamination – Some fluids are incompatible with slurries of cement. Certain liquid, solid, and chemical additives cause environmental problems. In many cases, fluids must be replaced by a less effective and more costly one.

Field Tests on Fluids



A basic understanding of the properties of fluids is necessary for all operations, and especially for well control.

- ♦ Mud Weight Test – A normal graduated arm and beam balance is the most common method of measuring fluid density.
 - If the mud or cement being measured contains trapped air or gas a pressurized balance should be used.
- ♦ Viscosity is the fluid's thickness and resistance to flow.

Field Tests on Fluids



- ◆ Rheology refers to the flow of liquids and gases.
 - These properties are necessary for:
 - Calculating frictional pressure losses.
 - Determining the mud’s ability to lift cuttings and cavings to surface.
 - Analyzing mud contamination by solids.
 - Chemicals or temperature.
 - Determining pressure changes in the well during a trip.
- ◆ API Water Loss:
 - The water loss test measures filtrate, or wall cake thickness as well as initial “spurt” and water losses.

- ◆ Chloride Test:
 - Chlorides exist in most liquids. A change in chloride content over the normal measured amount can indicate flow from a formation and/or formation type changes.
- ◆ Temperature Tests:
 - Changes to a temperature trend established from the fluid returning from the well can indicate potential pressured and transition zones.

Common Fluid Types



- ♦ Oil - is usually non-corrosive and will not cause clay swelling in the producing zone. Since oil is light, it is perfect for low pressure wells.
- ♦ Precautions when using oils:
 - The oil can have some wax, tiny particles of sand, solid, or asphalt that may damage the formation.
 - The oil may not be compatible with the reservoir fluids.
 - Oil is a fire hazard. It can be very slippery when pulling a wet string of pipe.

Common Fluid Types



- Oil should never be used in gas wells.
- Causes pollution if spilled.
- It may be corrosive if Hydrogen Sulfide or Carbon Dioxide is present.
- Oil may be too light or too heavy to maintain proper hydrostatic pressure.

The alternates for oil are diesel oil and kerosene, which are cleaner and non-corrosive, but more expensive.

Common Fluid Types

- ♦ **Oil and Synthetic Based Fluids** (Oil-In Water, Water-In-Oil Emulsions) - The advantages of oil or synthetic fluids are that they are usually stable in higher temperatures and less damaging to formations.
- ♦ **Gas** – Field gas is sometimes used in low pressure reservoirs where low surface pressures are required to control formations. It is volatile and extreme caution must be undertaken. Nitrogen is often used as it is non-volatile and inert to most formations. Foam, or higher annular velocities are used to provide proper hole cleaning.

Common Fluid Types



- ♦ **Fresh water, brines and muds**: Each type has desirable properties and uses and may be custom formulated to provide optimum properties.

Mud vs. Completion Fluids

- ◆ Drilling muds may have high viscosity in order to rid the hole of cuttings.
 - Higher mud weights can be used because they form filter cakes and have additives to prevent fluid loss to the formation.
- ◆ Completion fluids on the other hand are typically clear fluids with low viscosity and have been filtered to remove particles that can damage the formation.
 - Often when clear fluid is used there is nothing to minimize fluid losses and lost circulation may result.

- ◆ Brines are salts or a combination of salts. They generally dissolve into solution.
- ◆ A fluid's density can be increased by adding more salts.
 - The point where no additional salt will dissolve is called the saturation point. If more salt is added, it will not dissolve and fall to the bottom of the pit.
 - Addition of different salts may be necessary to achieve specific weights.

Brines

- ♦ Sodium chloride is the most frequently used single-salt brine. However, salt water can swell certain formation shale and clays.
- ♦ Some brines, such as mixtures of calcium and potassium may reduce clay hydration.
- ♦ Some salts can be acidic and cause corrosion at higher densities.
 - Special corrosion prevention additives may be added.

Crystallization

- ◆ Crystallization is the point in which the fluid starts to freeze.
- ◆ Crystallization reduces the fluid's density and ability to be pumped efficiently.
- ◆ Temperature has different effects on different solutions because every solution's tolerance to temperature is different.
- ◆ In cold climates, steam coils or other sources of heat should be available.

Packer Fluids

- ♦ Packer fluids remain between the casing and tubing to prevent collapsing of casing and burst of the production string.
- ♦ Therefore, a good packer fluid must be stable with time and temperature, non-corrosive, and economical.
- ♦ The fluid must also be able to be pumped and must not harm packer seals.



Plugs and Pills



- ♦ A plug is a mixture of additives that is meant to remain downhole.
- ♦ A pill is a mixture of additives that is spotted to a point in the well to perform a certain task.
- ♦ Plugs or pills are used for downhole problems. They have many uses:
 - Shut off salt water, oil and gas flows.
 - Seal fractures or stop
 - Seal casing leaks.

Plugs and Pills



- Stop lost circulation in permeable zones.
- Fix the injection profile in water injection or disposal wells.
- Help regain control of underground blowouts.
- Stabilize unconsolidated gravel zones.
- Enhance cement jobs by placing them ahead of the cement in order to avoid loss of low viscosity cement to thief zones.
- Reroute acid during well cleaning or stimulation.

General Fluid Safety



- ♦ Communication is essential and personnel should be aware of the dangers involved in handling and mixing chemical solutions.
- ♦ Certain chemicals can be harmful to people and the environment. The MSDS (Manufacturer's data sheet) should be kept on file and posted.
- ♦ For increased safety, protective clothing, goggles, gloves, etc. should be worn when handling chemicals.

General Fluid Safety



- ♦ Wash stations must be kept in good working order.
- ♦ If chemicals get in your eye, immediately have it flushed out with water and report the incident to a supervisor.