Use of chemicals within the oil & gas sector

Module 1

Contents

- Chemicals in the Sector
- Harmful v Hazardous
- Drilling fluids
- Cementing Chemicals
- Completion Chemicals
- Production Chemicals
- Radio-Active Substances

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Chemical content and properties

- Is the chemical made up of one component or a mixture of components?
- Gas, liquid or solid?
- Soluble in water or in oil?
- The properties of the chemical determines fate in the environment.

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Chemicals – intrinsic properties

- Is the component toxic?
  - To humans
  - To animals (fish, algae, crustacean, earthworms etc.)
- Is the component bio-degradable?
  - What is the half life, how long will it take to break it down?
- Is the component bio-accumulative?
  - Is it soluble in fat and will be transferred up the food chain?

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Harmful vs hazardous

- Harmful substances may cause adverse effects as a result of:
  - Amount of discharge
  - Time of discharge
  - Concentration of discharge
  - Mode of discharge
- Hazardous substances may cause adverse effects as a result of
  - Intrinsic properties (toxicity, & potential for bioaccumulation).

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Chemicals in the oil & gas sector

- Drilling and well chemicals
- Production chemicals
- Injection chemicals
- Pipeline chemicals
- Gas treatment chemicals
- Utility chemicals
- Chemicals added to the export flow
- Water trace components
- Emergency preparedness

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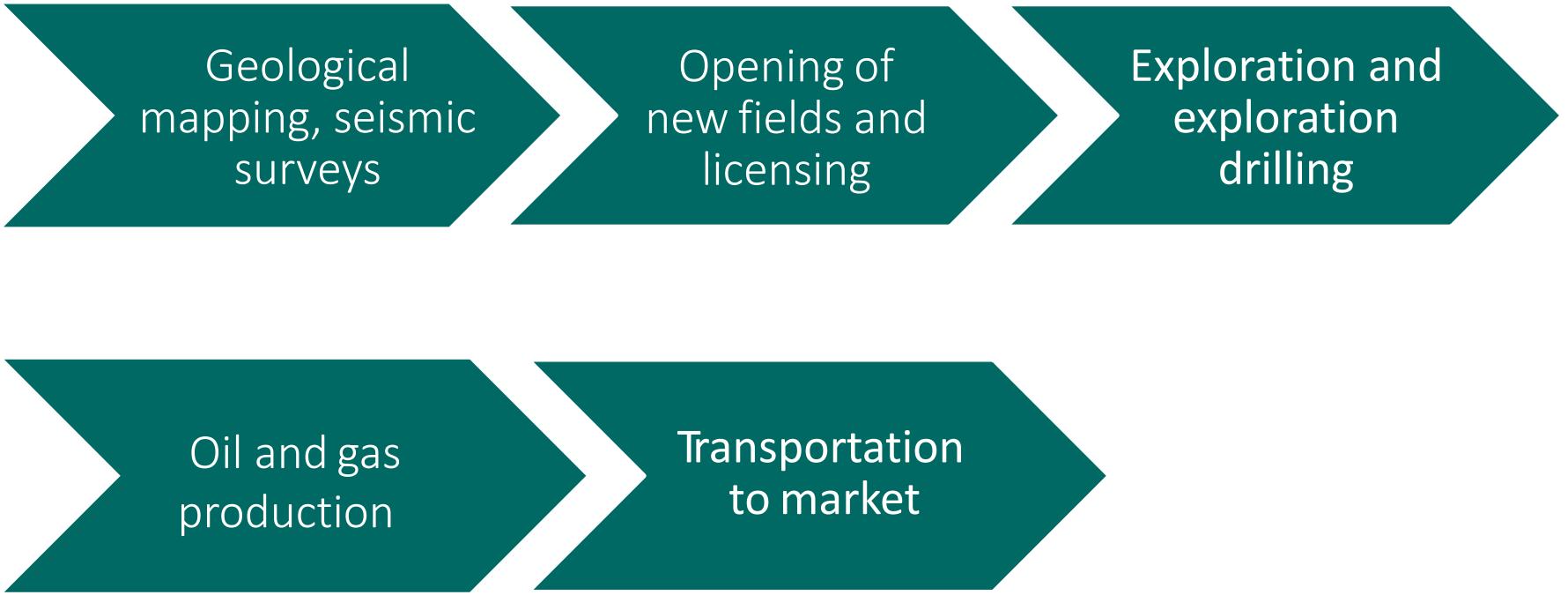
Main activities in the oil and gas value chain



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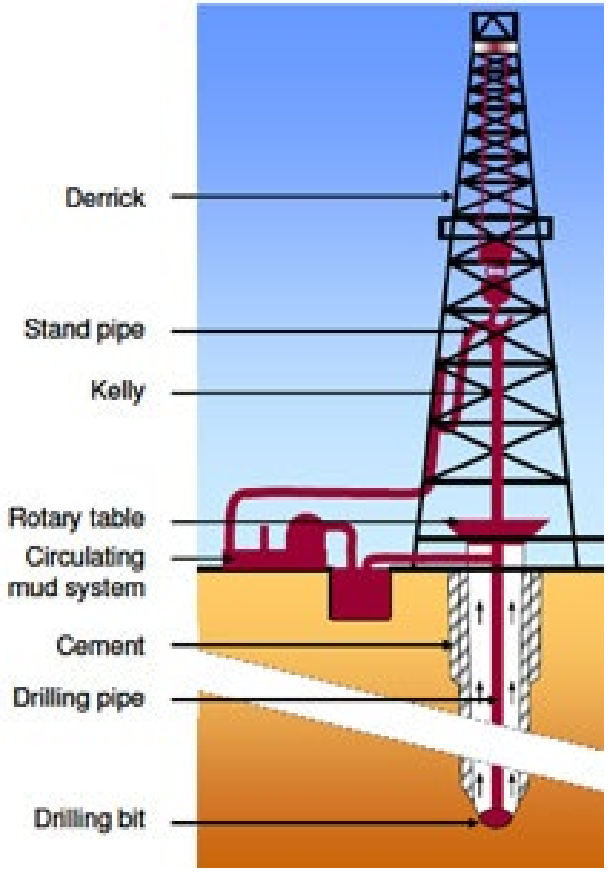
Discharges to environment



- Drill cuttings (rocks and sand from the well)
- Drilling fluids (drilling muds)
- Produced water (containing oil and chemicals from production)
- Drainage water
- Domestic water
- Sewage
- Cooling water
- Solid waste
- Spills

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What are drilling and completion fluids?

- Water-based drilling fluids (WBDF) or oil-based drilling fluids (OBDF) used during well drilling.
- More recently, synthetic based drilling fluids have been developed – based upon a synthetic fluid rather than an oil – typically used offshore, greater environmental acceptance than OBDF.

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Drilling fluid

- Drilling fluid forms the continuous face within the well and in which all components are carried.
- Due to material costs and environmental concerns, WBDF is always the first drilling fluid to be considered
- Drilling fluid and drill cuttings = drilling mud

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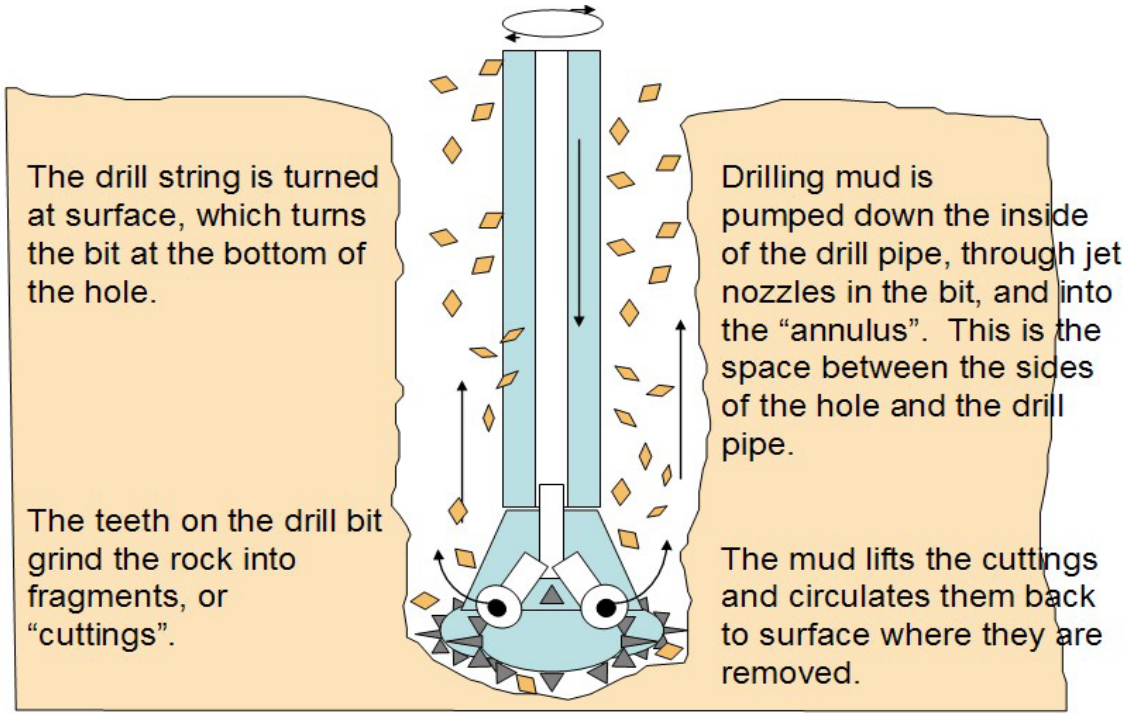
Drilling fluids



- Primary function of drilling fluids in drilling operations include:
  - Removal of drilled cuttings (rock chippings) from the wellbore to the surface
  - Control of the formation pressure
  - Cooling of the drill bit

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Drilling fluids and cuttings

Removal of cuttings from well:

- Drilling fluid must have sufficient viscosity and velocity.
- In WBDF this is achieved through adding bentonite clay or polymers (compound of high molecular weight with large individual particles).
- At the surface, drilling fluid is separated from the cuttings and the drilling fluid is re-circulated through the well.

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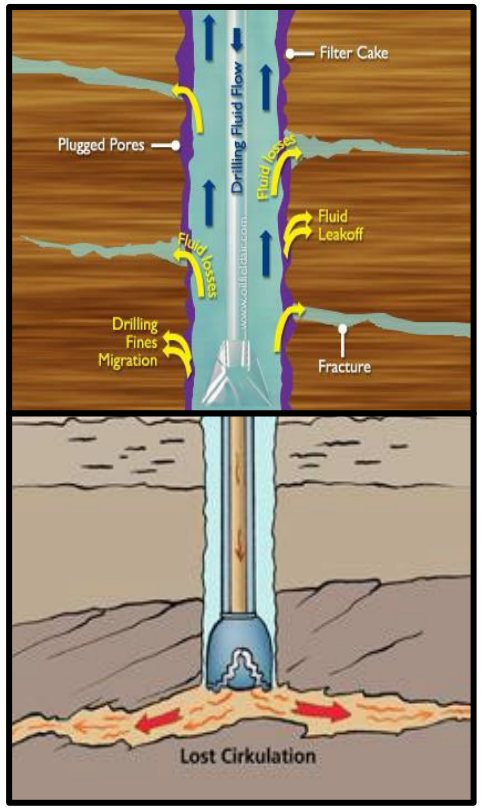
Drilling fluids functions



Seal permeable formations and maintain well stability:

- Prevent the ingress of formation fluids into the well
- Prevent the wall of the well caving-in
- Avoid fluid loss, especially when drilling through porous and permeable formations
- WBDF tend to react with salt-bearing and clay formation
- OBM reduce interaction

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Drilling fluid, functions continued

Cool and lubricate the drilling tools and drill bit:

- Especially important at depth and inclined drilling
- Lubricate & transmit hydraulic power to the drill bit
- Both water and oil are effective at cooling the drill bit but at depths with higher temperatures problems result due to the boiling point of water
- OBDF better retain their properties at high temperatures and pressures

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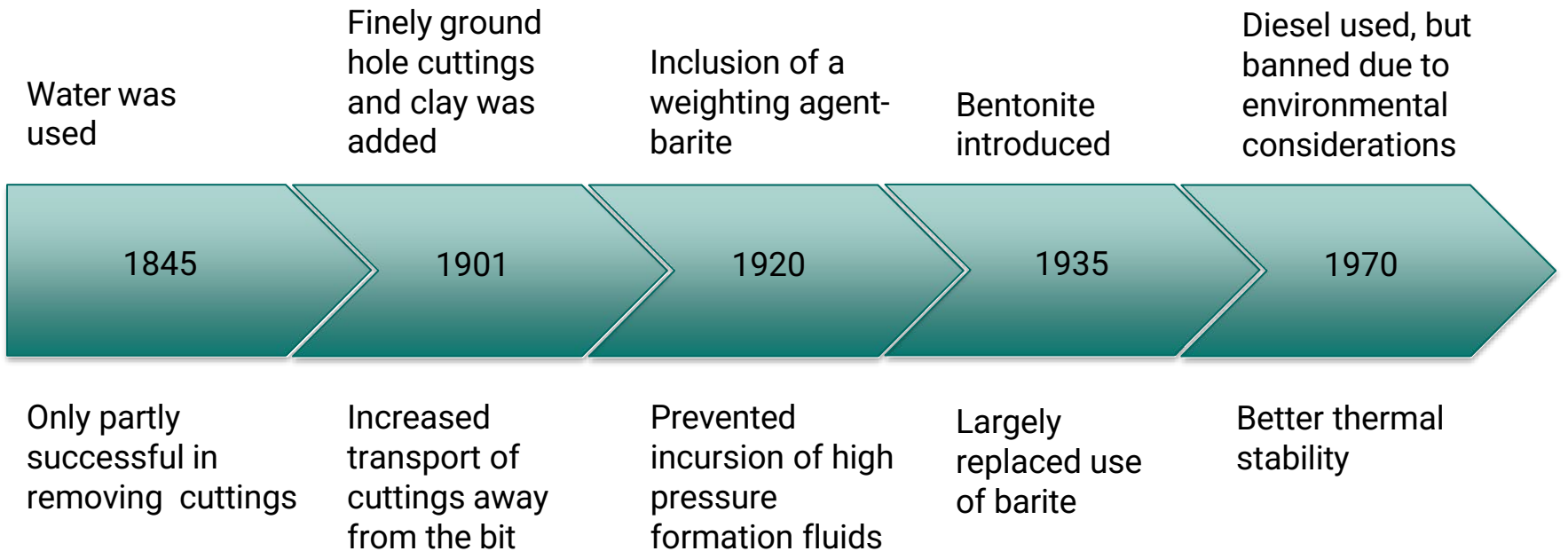
History of drilling chemicals



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Water-based drilling fluids (drilling muds)

- Water is the base of the WBDF
- Used in exploration wells, top hole sections and in simple wells
- WBDF can, within Europe, normally be allowed to be discharged to environment following pre-treatment

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WBDF – additives

Additive	Function
Salts/brine Polymers	Inhibitor for reactive clays, in combination with polymers
Viscosifier/clay	Get the right viscosity, gel strength and filtration rate
Shale inhibitor, scale inhibitor	Prevent interaction with shale, prevent precipitation of scale
Lubricant	Reduce friction (aromatic and naphthenic compounds)
Defoamer (e.g. aluminium stearate)	Minimize foaming
Corrosion inhibitor (alkaline chemicals, NaOH)	Minimize corrosion of drill pipe and casing
Biocide	To reduce the biological growth
Weighting agent (barite)	Match formation pressure, achieve desired density
Fluid loss additives (starch, polyanionic cellulose)	Added to reduce loss rate
Bridging agent (sized salt, calcium carbonate)	Added to bridge across pores or fractures to prevent loss of drilling mud
Emulsifier	Disperse small amounts of oil from the formation or added to increase lubricity

Oil-based drilling fluid

- Oil is the base fluid (mineral oil, paraffin etc)
- Used in long, complicated & horizontal wells within complex geology
- Used in the reservoir zone (high temperature and pressure)
- Normally contain components that are toxic in nature
- OBDFs are not allowed to be discharged to the environment
- OBMs require treatment and disposal

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OBDF – additives

Additive	Function
Brine phase (salt)	Minimize interaction between the mud and formation clays and salt, adds density to the mud
Emulsifiers / surfactants	Create a stable invert emulsion, oil wet cuttings to ensure good transport
Lime (calcium hydroxide)	Minimize corrosion, convert additives into oil soluble forms
Viscosifier (organo clay)	Get the right viscosity
Weighting agent (barite)	As for water based systems
Organic fluid loss additive (asphaltine, rubber, coke resin, lignite-based)	As for water based systems
Bridging material (calcium carbonate, dolomite, marble, graphite)	As for water based systems

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Water-based drilling fluids

Why use water-based drilling fluids?

- Reduced costs
- Healthier working environment (fewer noxious fumes)
- Reduced harm to the marine environment
- Avoidance of waste problems

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Effects of WBDF

- Pre-treatment prior to discharge is recommended.
- WBDF have little effect when discharged offshore or on land (inert, low toxicity, but high pH and high salt content).
- Offshore: will cover the seabed if discharged, will temporarily change the seabed as feeding ground for fish.
- Land based: need to be placed in holding pits prior to treatment.

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Effects of OBDF

- Severe effect if discharged offshore or on land
- May also be harmful to people's health
- Drilling fluids and cuttings must be taken to treatment plants to be reclaimed or destroyed
- Trials ongoing on cleaning the cuttings on board, and discharge if oil content is less than 1%

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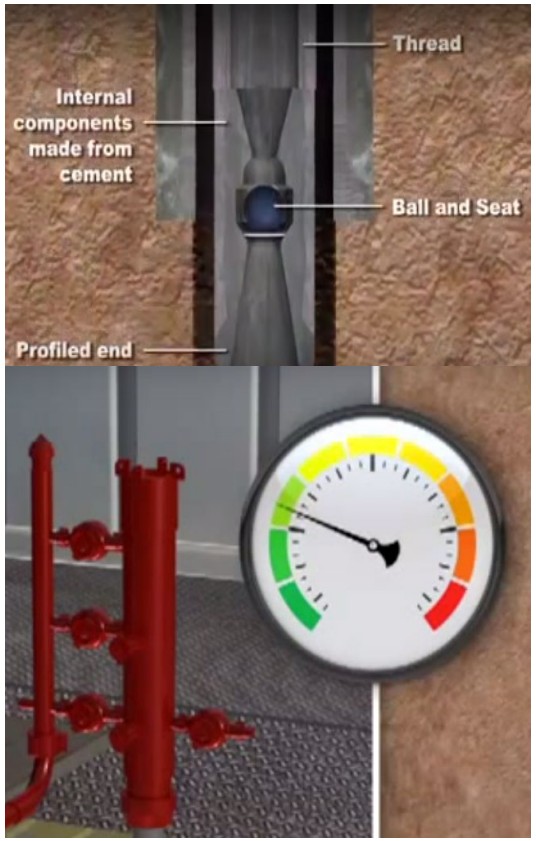
Use of cementing chemicals



- After drilling, once well section conductor casing is installed
- Cement slurry is used for fixation and sealing
- Used for safety reasons to ensure pressure integrity
- Support for BOP/well head

Cementing chemicals

Chemical	Function
Cement	Strength/hardening
Dispersants and surfactants	Keep particulates and droplets suspended
Retarder	Ensure the right hardening rate
Polymers/glycol	Minmize loss to formation
Vegetable oils	Anti foam

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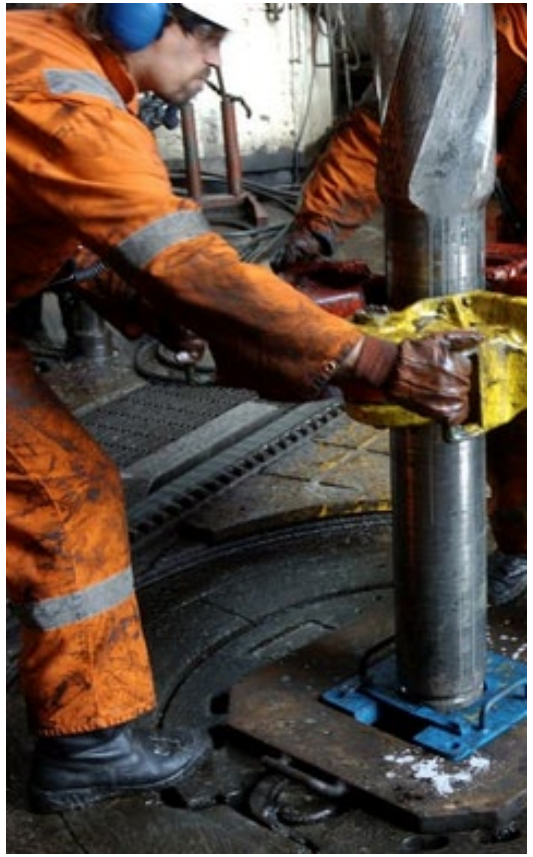
Completion



- Completion is the process of making a drilled well ready for production testing and ultimately production
- This will only be carried out if the reservoir is going to be produced
- Could be an exploration well that is turned into a production well

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Completion chemicals

- Keep the integrity of the well until it is ready to produce hydrocarbons
- Secure the well from ingress of unwanted formation fluid
- Cleaning/clearing the well
- Establishing the production tubing and its associated down hole tools

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Completion chemicals

- Keeping the integrity of the well:
  - Salt brine, surfactants
- Cleaning of the well:
  - Surface active agents, inhibition fluids
  - Advanced polymers
- Preventing biological growth and corrosion:
  - Biocide, inhibition fluids

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Other chemicals

Chemical	Function
Wash chemicals	Oil rig cleaning Normally green or yellow Some may be discharged
Grease	Used when the drill string and conductors are connected Could have red or black components May partly be discharged
BOP-fluid	Used when valves are pressurized and activated Parts will be discharged (when testing BOP) Could have red components
Hydraulic fluids	Used in closed systems Could have red or black components Normally not discharged, only if leakage/sweating

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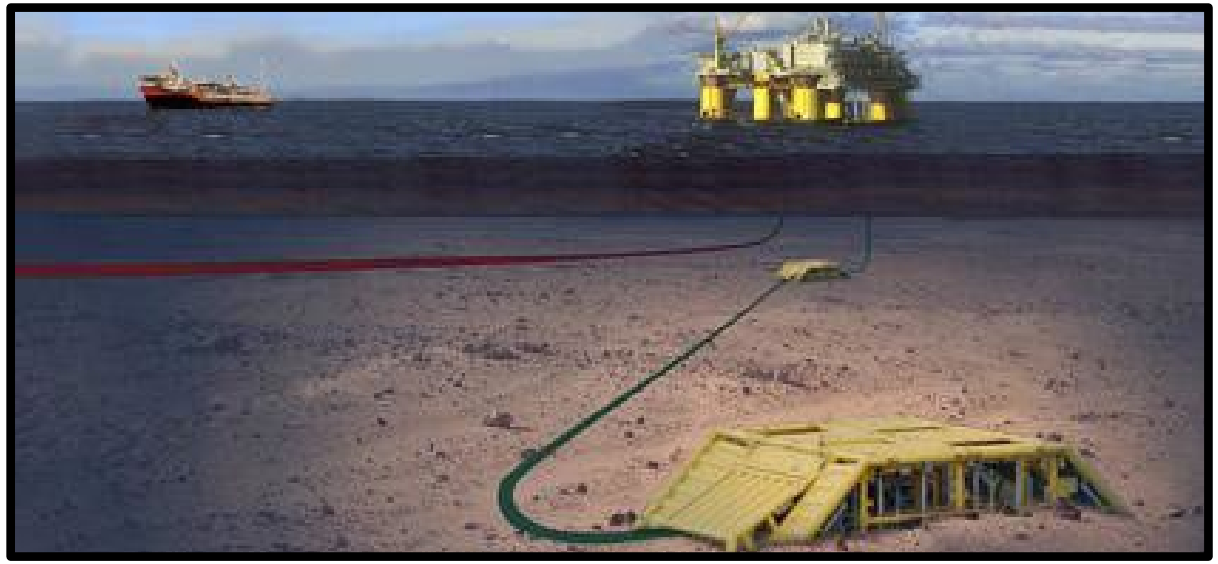
Production process



The production phase involves taking the oil and gas from the well-head to stabilized marketable products.

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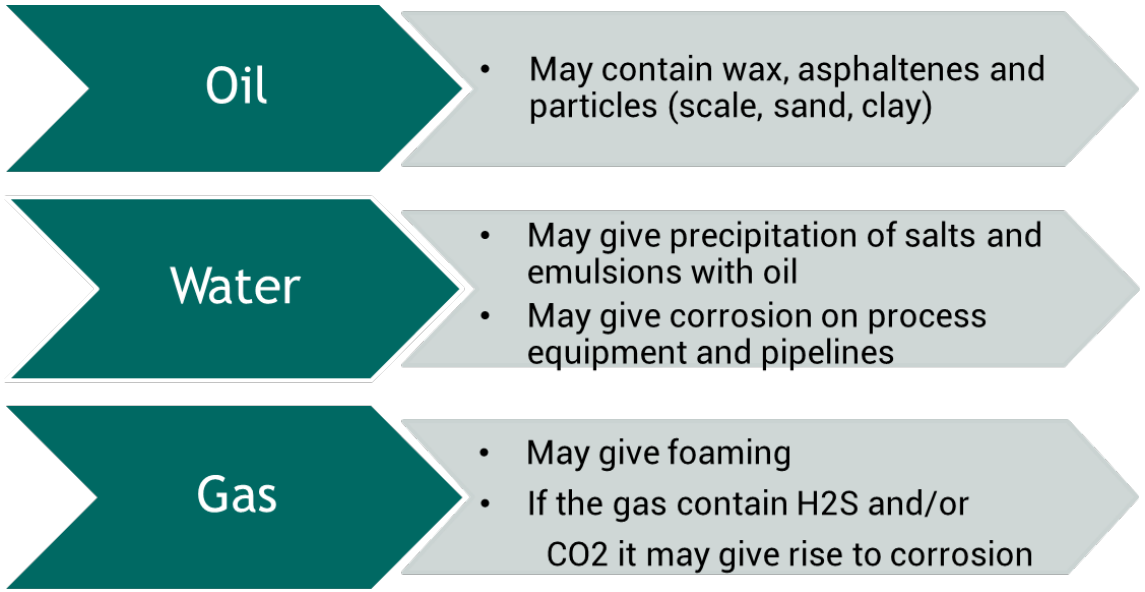
Production chemicals



- Both chemical and physical changes can occur to the well stream fluids, as they are transported from the reservoir through the processing system.
- Production chemicals can help to address or minimise these changes.

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Production chemicals – application

Situation	Consequence
Foaming	Reduced production
Corrosion	Damage process equipment, production lines and export lines
Scaling	Reduced production, scaling on process equipment and reduced functionality
Emulsions	Discharge water with high oil content and high water content in exported oil
Waxing	Scaling, reduced production, separation problems
Biolological growth	Injection problems, presssure loss, corrosion and fouling in process equipment
Hydrate formation	Ice pig formation in pipelines and process equipment (hydrocarbons and water)

Production chemicals – how they work

Situation	Consequence
Defoamer	Reduced the surface tension on the gas bubbles
Corrosion inhibitors	Establish a protective layer on the surface of the metal
Anti scale agent	Hamper formation of crystal growth
Emulsion breakers Flocculants	Reduce surface tension on the water droplets. The droplets coagulate to bigger droplets that separated due to the self-weight or gravity
Anti waxing	Reduce the wax particles ability to grow
Biocides	Toxic towards bacteria and limit the bacterial growth
H2S/O2- Scavenger	React with H2S, clean the gas. Reduce the O2-content in the gas
Hydrate inhibitor	Change the freezing point for ice plugs that is formed at a certain pressure and temperature

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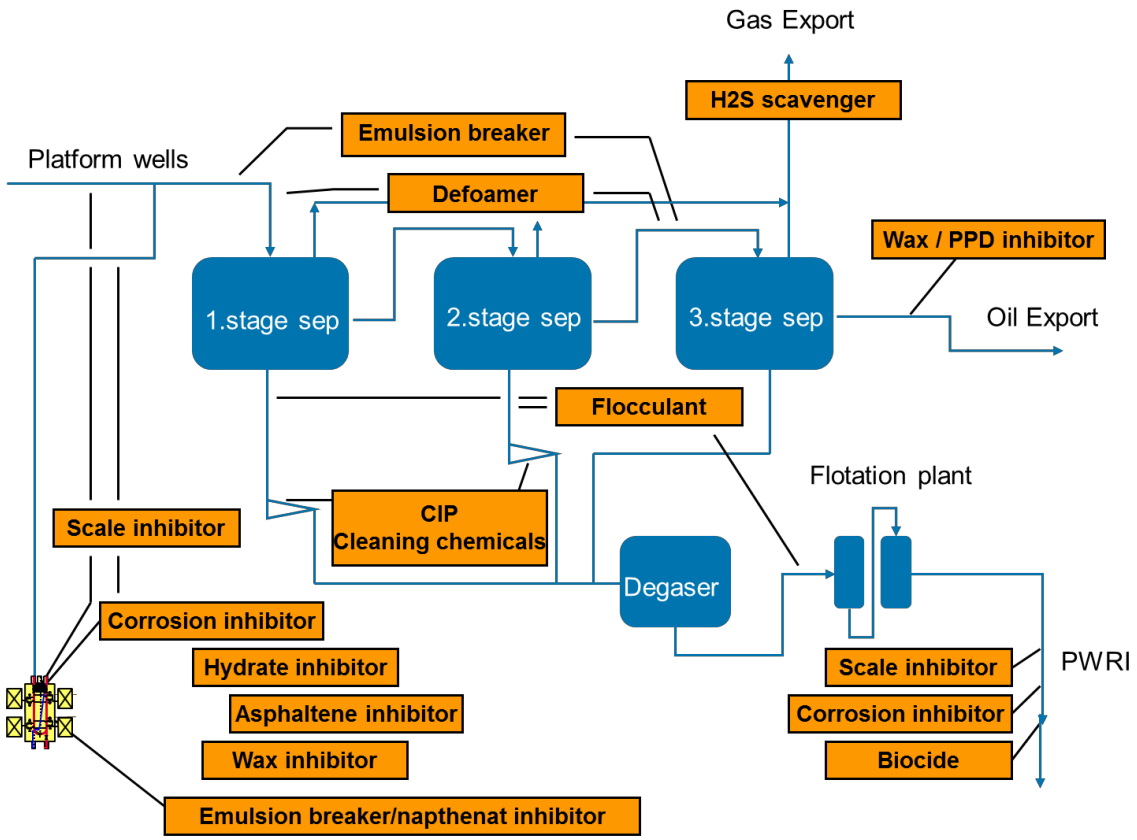
Oil export string



Production chemicals

Production Chemicals	Water injection Chemicals	Gas treatment Chemicals	Utility Chemicals	Pipe line Chemicals
Scale inhibitor	Scale inhibitor	H2S scavenger	Corrosion Inhibitor	Hydrate inhibitor
Emulsion breaker	Biocide	TEG	CIP cleaning chemicals	pH stabilizer
Defoamer	Nitrate	Corrosion inhibitor	O2 scavenger	Corrosion inhibitor
Flocculant	Corrosion inhibitor	pH stabilizer	Biocide	Wax inhibitor
Corrosion inhibitor	Flow improver	Amin		PPD
Hydrate inhibitor	Defoamer			
Wax inhibitor	O2 scavenger			
Asphaltene inhibitor				
Naftenate inhibitor				

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Discharge of production chemicals

- Production chemicals normally contain green, yellow and some red components.
- Biocide can contain red components.
- If chemicals are water soluble, may be discharged through produced water.
- Ideally, produced water is injected down injection wells – but, in many cases this is not happening.
- Gas treatment chemicals normally follow the gas (injected as fuel or exported).
- Support chemicals (cleaning, hydraulic fluids, biocides, slop tanks).

Radioactive substances used in oil industry

- Bit cuttings from any well dug will contain Naturally Occurring Radioactive Materials (NORM), with the actual amount the same as was present in the earth removed at that location.
- There are reports where cuttings have set off radiation alarms at disposal facilities due to elevated NORM levels in the soil.
- Typically, the removed soil from drilling is substantially below the NORM levels required to set off a radiation portal alarm.
- Common examples of NORM include uranium, thorium, potassium and radium.

Thank you

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