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Module 1

FUNDAMENTALS OF SAND MANAGEMENT

CONTENT

- *Introduction*
- *Sand production principles*
- *How does sand production occurs ?*
- *Consequences of sand production*

INTRODUCTION

Sand management is the process by which sand grains and formation particles are produced along with the hydrocarbons, processed and disposed in a cost-effective and environmentally compliant safe manner

The process is labour intensive and to be successful requires the contribution of many disciplines such as geology & geosciences, production technology, flow assurance, geomechanics, management, operating/field knowledge and expertise.

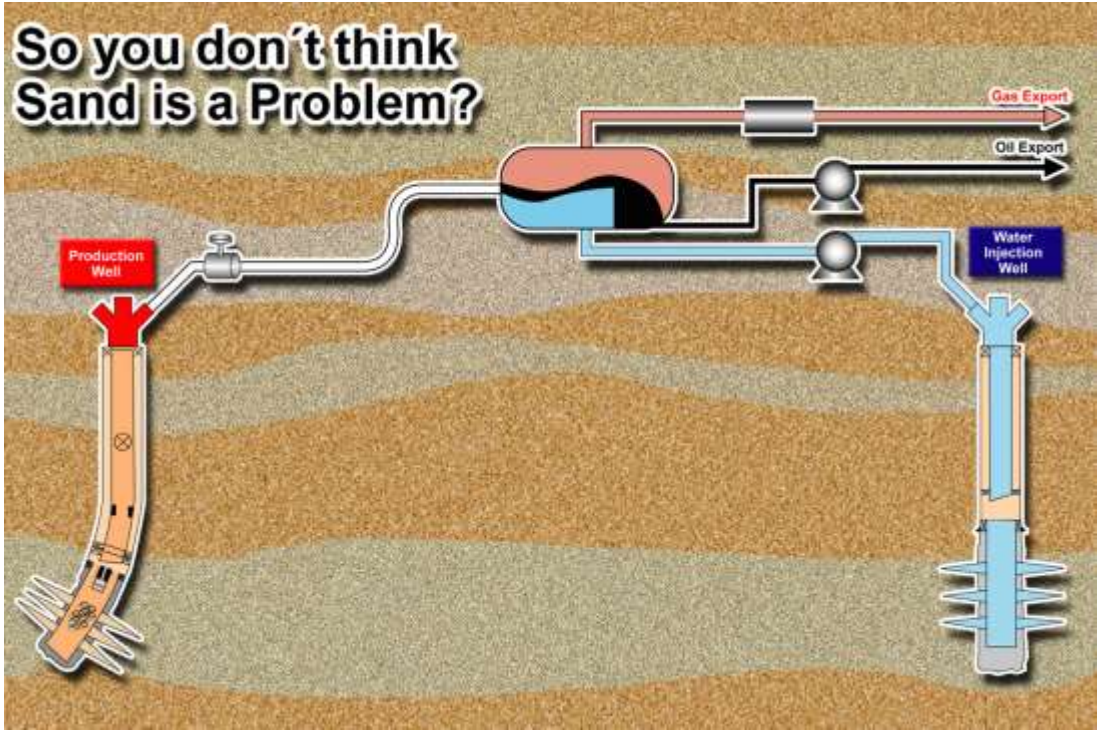
Sand production is considered a detrimental process to production however, *that is not the case*.

Management of sand production can lead to successful and productive field life and improved reserves recovery

INTRODUCTION (Continued)

Sand production impact all aspects of the drilling, completion and production stages in the life of a field.

- Most sandstone reservoirs will produce sand at some point in their productive life
- The sand management process can be planned or a remedial one
- Most fields/wells on sand management are the result of an unplanned event such as completion failure



Courtesy of BP

INTRODUCTION (Continued)

The damage caused by sand production affects all aspects of field's productive life.

Failed Completion

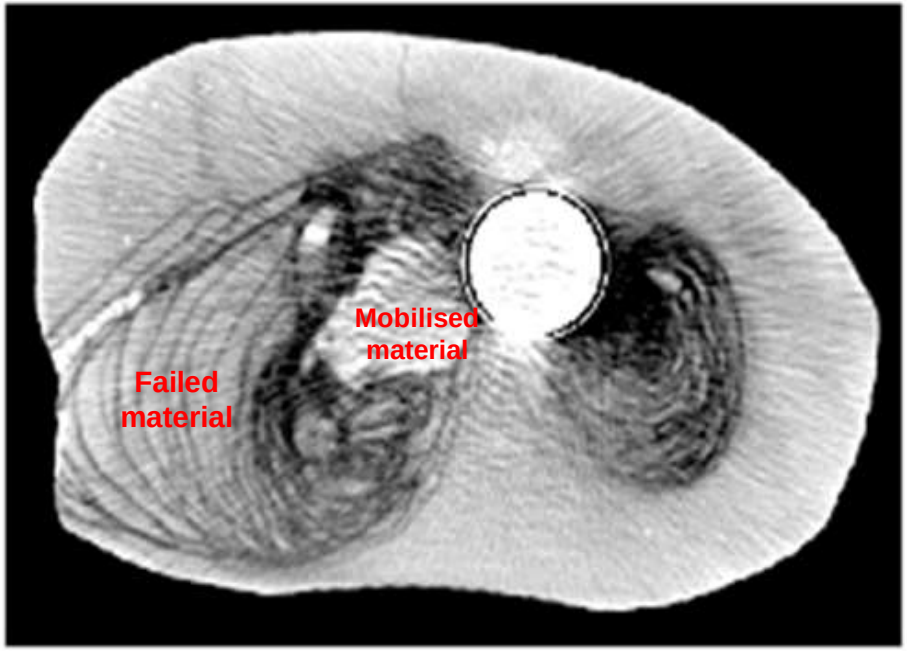
Eroded sand screen

Sand deposition at the flowlines

SAND PRODUCTION PRINCIPLES

Sanding occurs in all types of wells, oil & gas producers, injectors and storage wells

- Intact rock failure, granular material failure and grain mobilisation are the mechanisms that lead to sand production
- Intact rock failure and granular material failure are driven by the stresses acting at the near wellbore and area
- In many cases sand production can increase productivity/injectivity from/to a reservoir



After Palmer I. 2000

SAND PRODUCTION PRINCIPLES (Continued)

It is common to *identify* the severity of sand production by the mode of sanding (Rate) and volumes measured at surface. The table below presents four(4) modes of sanding based on liquid hydrocarbon production i.e. lbs of sands per 1000 bbls of fluids

MODE	VOLUMES* [lbs/1000 bbls]	WHEN DOES IT OCCUR	CHARACTERISTICS
Initial / Start up	< 700	Well start up, initial flow(DST), clean out	Large volumes of sand & associated mud particles
Transient	< 100	Change of operating conditions	Also known as "sand bursts" that occur sporadically
Continuous	< 50	Anytime but it increases from there	Low "tolerable" volumes on a continuous basis
Catastrophic	-	Start up or any other time	Sudden event that is sometimes associated with an increase in WOR

SAND PRODUCTION PRINCIPLES (Continued)

Sanding is perceived as an erratic process both from open hole or cased/perforated completions

After Tovar et al 2010

HOW DOES SANDING OCCURS ?

Sand production occurs when the mechanical loads acting on the wellbore exceeds the capability of the rock matrix to withstand these loads. At this point two (2) conditions must be present for sanding to occur:

1. Mechanical failure of the rock at the near wellbore occurs, this implies that an intact reservoir rock matrix ”breaks” transitioning into clusters or granular material as part of the deformation process

2. This failed material must be ***mobilised*** from the near wellbore along with the produced fluids into the wellbore and up to surface.

The production fluids generate capillarity, seepage and drag forces that can overcome the cohesive forces keeping the failed material in place. Water production has been identified with the initiation of sand production.

HOW DOES SANDING OCCURS ? (Continued)

Due to the direction of flow (into the reservoir) in *water injection wells* the sequence of events is different but the engineering principles causing sanding remains similar

1. Mechanical failure of the rock at the near wellbore, reservoir rock matrix ”breaks” transitioning into clusters or granular material as part of the deformation process. *Such a failure occurs during the shutdown of the injector due to a pressure pulse* (Water hammer effect) *generated during the sudden injection of fluids*

2. This failed material is ***mobilised*** from the near wellbore. The transient equalisation of reservoir pressures at the near wellbore area and zones of varying permeability allow cross-flow of water prior to the “equalisation” of pressure at the sand face.

As a result, the two (2) conditions are met for water injectors and sand is produced into the wellbore. This occurs during well’s shutdown

CONSEQUENCES OF SAND PRODUCTION

PROCESS	CONSEQUENCE	RISK	OBSERVATIONS
Drilling	Increase in NPT, poor hole quality and increased drilling and completion time	**Medium**	Higher rig and materials cost
Completion	Well requires frequent well intervention	**Low**	High cost associated with intervention & recompletion
	Completion failure and loss of the well	**High**	Screens, tubing and DHSV failure
Production	Erosion of surface equipment	**High**	Tree valves, chokes, flowlines
	Poor separation of gas/fluids/solids	**Low**	Increased OPEX due to extended maintenance programs
	Increase in hydrocarbon production	**Low**	Improved reserves recovery
Disposal	Higher environmental cost & risk	**Medium**	To meet local regulations
	Additional monitoring, testing	**Low**	Data gathering and processing programs.

CONSEQUENCES OF SAND PRODUCTION (Continued)

Quartz is one of the hardest natural minerals on earth and the damage it causes to equipment is significative

Courtesy of Dragon Oil

MODULE 1 - SUMMARY

Sand production is a phenomena that occurs in all types of sandstone reservoirs during their productive life. In stronger rocks this might occur at a later stage in the field's life.

Managing sand production is a complex process that increases the risk to completion and production operations in oil, gas, storage and injection wells.

Such a risk vary between very severe to moderate and low. In all cases it might cause mechanical integrity problems, environmental issues all leading to higher cost.

Wellbore filling, failed screens, eroded tubing and valves are the result of sand production in wells. Failed chokes, valves, flowlines, poor separator performance and corroded flowlines are some of the potential consequences of sand production

Improved well, reservoir performance and reserves recovery are some of the positive outcomes of effective and efficient sand management

MODULE 1 – SUMMARY (Continued)

Sand production is caused by the loading being applied to the reservoir rock that induces mechanical failure of the intact reservoir matrix

Fluid production/injection then mobilises the failed material from the near wellbore into the wellbore and up to surface. These two (2) conditions must be met (Rock failure and mobilisation) for sanding to occur

In water injectors the same engineering principles apply but the sequence of events which generates the two (2) conditions (Rock failure and grain mobilisation) varies

A similar situation occurs in gas producing wells however, the tolerance of gas wells to sand is much lower than that in oil producers and water injection wells.

In wells producing heavy crudes, such a potential risks are mitigated by the viscosity of the crude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