

Field Development

Production Optimization

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Production Optimization

- What is our **Challenge?**
 - how to produce our oil and gas wells without flow restrictions
- What is our **Objective?**
 - how to maximize the value of our asset / Wells
- What is our **Vision?**
 - To achieve an integrated and valuable Upstream Oil & Gas system
- What is our **Mission?**
 - To produce hydrocarbons in safe manner

Production Optimization

What is the Solution?

- Understand / Through monitoring, surveillance
- Translate / **Vision** / Target
- Reproduce / Using Appropriate Models / **Reality**
- Integrate / All the field elements to be **linked** all together
- Optimize / Extract maximum **value** from the field
- Forecast / Using **IPM** / Integrated Production Modelli

Production Optimization

Well Value Assurance

Variables Affecting Optimum Production Rate:

Well Parameters:

- Well Head Flowing Press (WHFP)
- Water Cut – WC%
- Gas Oil Ratio – GOR%
- Inflow Performance – IPR
- Tubing Size
- **Well Head Choke Performance**

Production Optimization

Well Value Assurance

Variables Affecting Optimum Production Rate:

Reservoir Parameters:

- Gas Break Through
- Water Break Through
- Sand Production
- **Scales Precipitation**
- Gas Hydrate
- Behind Casing Zonal Communication / Cross Flow / Dump Flow

Production Optimization

Well Value Assurance

Skin Factor and Flow Efficiency

- Skin is a Measure of Damage around a Wellbore
- Skin caused by:
 - Drilling
 - Completion
 - Stimulation / Frac
 - Injection
 - Production
 - **Scale around the Wellbore**

Production Optimization

Well Value Assurance

- Skin Factor and Flow Efficiency
- +ve Skin----- High Press Drop ----- Damaged Wellbore ----- Lower PI
- -ve Skin ----- Low Press Drop ----- Undamaged Wellbore ----- Higher PI
- Skin Affects Flow Efficiency Defined As:
$$\text{Flow Efficiency} = Q \text{ with Skin} / Q \text{ without Skin}$$

Production Optimization

Well Value Assurance

Skin Factor and Flow Efficiency

- Affect of Skin on Flow Efficiency is shown as below:

SKIN	FLOW EFFICIENCY
- 02	133%
0.0	100%
+ 02	80%
+ 06	57%
+ 12	40%
+ 20	29%
+ 30	21%
+ 100	08%

Well Flow Assurance

Well Flow Assurance, Agenda

- **Inorganic Scale Deposition**
- **Downhole Corrosion**
- **Waxes and Asphaltenes**
- **Gas Hydrates**

Well Flow Assurance

• Inorganic Scale Content:

- Inorganic Scales Deposition
- Causes of Scale Deposition
- Where Scale Occurrences
- Types Of Scales
- Scale Monitoring
- Scale Prevention
- How to solve / Well Intervention

Well Flow Assurance

Scales Problems

Inorganic Scales Deposition

- Inorganic salts precipitated within production System
- Composition of scale varies widely, most common
 - Calcium Carbonates / Calcium Sulphate
 - Sodium Sulphate
 - Barium Sulphate / Strontium Sulphate
- Speed of deposition can effect the appearance and properties of the scale

Well Flow Assurance

Scales Problems

Causes of Scale Deposition

- Main causes of scaling are:
 - Pressure Drop
 - Temperature Change
 - Mixing of two incompatible waters
 - Exceeding the solubility / fluid viscosity
 - Flow Velocity

Well Flow Assurance

Scales Problems

Causes of Scale Deposition

- Main causes of scaling are:
 - Pressure Drop
 - Temperature Change
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Well Flow Assurance

Scales Problems

Causes of Scale Deposition

- Other factors are involved:
 - Evaporation
 - Agitation
 - Long exposure time
 - Change of PH

Well Flow Assurance

Scales Problems

Types Of Scales

- Sodium Chloride = NaCl
- Calcium Carbonate = CaCO₃
- Calcium Sulphate = CaSO₄
- Barium Sulphate = BaSO₄
- Strontium Sulphate = SrSO₄
- Iron Compounds ** = FeCO₃ / FeSO₄

(** Need to be milled out)

Well Flow Assurance

Scales Problems

Where Scale Occurrences

Generated in a variety of Locations:

- Up Stream
 - Formation matrix and Fracture
 - Well Bore
 - Well Completion
 - Downhole Pumps
 - Protected Casing
 - Well Heads, X-Trees And Production Chokes

Well Flow Assurance

Scales Problems

Where Scale Occurrences

Generated in a variety of Locations:

- Down Stream
 - Separators and Heaters
 - Storage Tanks
 - Pumps
 - Flow Lines
 - Waterflood and Salt water disposal Systems

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Scales Problems

Cont'd Types Of Scale

Sodium Chloride

- Simplest type of scale
- Builds up in wellbore
- Caused by super-saturation , due to evaporation or decrease in BHT
- Readily dissolved by backwashing with fresh water

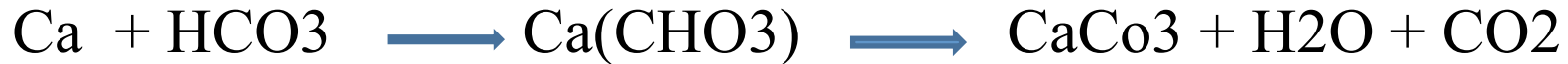
Well Flow Assurance

Scales Problems

Cont'd Types Of Scale

Calcium Carbonate (CaCo3)

- One of the most frequently encountered



- Causes of CaCo3 Scale include:
- Increased in BHT
- Increased in PH

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Scales Problems

Cont'd Types Of Scale

- Cont'd Calcium Carbonate (CaCO_3)

- Increased in contact time / scale also becomes harder
- Increased in the total salt content
- Increased the flow turbulently

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Scales Problems

Cont'd Types Of Scale

Calcium Sulphate

- Various forms, including:
 - Gypsum ($\text{CaSO}_4 \cdot \text{H}_2\text{O}$)
 - Anhydrite (CaSO_4)

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Scales Problems

Cont'd Types Of Scale

Calcium Sulphate

- Causes of Calcium Sulphate scale include:
 - Reduction in pressure
 - Mixing of two waters
 - Increase in Magnesium ions

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Scales Problems

Cont'd Types Of Scale

Calcium Sulphate

- Causes of Calcium Sulphate scale include:
 - Agitation
 - Evaporation of water due to evolution of free gas
 - Hydrates in gas wells

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Scales Problems

Cont'd Types Of Scale

Barium Sulphate (BaSo_4)

- Heavy, dense, non acid soluble
- Inhibition Program is essential
- Causes of Barium Sulphate scale include:
 - Mixing of incompatible waters
 - Decreases in BHT and reduction in BHP

Well Value Assurance

Scales Problems

Cont'd Types Of Scale

Strontium Sulphate (SrSO_4)

- Closely related to (BaSO_4)
- Occurs in minor component in other scale type

Well Value Assurance

Scales Problems

Cont'd Types Of Scale

Iron Carbonate (FeCO_3) and

Iron Sulphate (FeSO_4)

- Concentration low in seawater and in connate water
- Unlikely to be source of severe plugging
- Rust inside tubing / flow lines may be a source of iron scale

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Scales Problems

Cont'd Types Of Scale

Radioactive – NORM

- Occurs in minor component in other scale type
- Difficult in removal and disposal
- Well is to be shut in immediately - HSSE

Mercury Liquid

- It has a poison affect on human being - HSSE
- Well is to be shut in immediately

Well Flow Assurance

Scales Problems

Scale Monitoring

- Water and gas samples - to be taken collected during well tests for further analysis
- Scale Coupons – to be installed upstream choke in donwhole nipple & down stream choke after sample point.
- Computer based Scale prediction programme to be available / Scale Module / Scalechem

Well Flow Assurance

Scales Problems

Scale Removal

- Removal Methods
 - Mechanical
 - Chemical – Water Soluble
 - Chemical – Acid Soluble
 - Chemical – Acid Insoluble

Well Flow Assurance

Scales Problems

Scale Removal

Mechanical Methods:

- Reperforating - to bypass the plugged perforations intervals
- String shot – Sonic tools, drilling, reaming, tubing, casing, open hole
- Scrappers of reaming – Surface flow lines

Well Flow Assurance

Scales Problems

Scale Removal

Chemical Methods:

- Chemical Removal – Water Soluble Scale
 - Sodium Chloride – NaCl
 - Newly formed Gypsum – $\text{CaSO}_4 \cdot \text{H}_2\text{O}$
 - Readily dissolved with fresh water

Well Flow Assurance

Scales Problems

Scale Removal

Chemical Methods:

- Chemical Removal – Acid Soluble Scale
 - Calcium Carbonate – CaCO_3
 - Iron Carbonate – FeCO_3
 - HCl or Acetic acid most commonly used

Well Flow Assurance

Scales Problems

Scale Removal

Chemical Methods:

- Chemical Removal – Acid Insoluble Scale
 - Calcium Sulphate – CaSO_4
 - Chemicals convert to acid soluble compound (e.g. CaCO_3)

Production Optimization

Well Flow Assurance

Scales Problems

Scale Removal

Chemical Methods:

- Chemical Removal – Acid Insoluble Scale
 - Barium Sulphate – CaSO_4
 - Strontium Sulphate – SrSO_4 , Chemical methods are being developed
 - Generally considered as Inert – mechanical methods

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Scales Problems

Scale Prevention

- Scale could be prevented by two ways:
 - Inhibiting and distorting the crystal growth
 - Preventing crystal from adhering and forming deposits
- Scale can be prevented with – 10 ppm inhibitor
- Continuous Injection system is the most economical and effective dosing methods.

Well Flow Assurance

- Scales Problems
- How to solve / Well Intervention
- Inhibition Technique
- Acid / Other Dissolver to dissolve the scale
- Rigless / Coiled Tubing with the impact tool
- Other new intervention / Clean Well Weatherford System
- Rig / Workover

Q & A

Thanks