MANAGING MATURE FIELDS IN PERTAMINA EP

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VP Enhanced Oil Recovery
Pertamina EP
Historical Production
Challenged in Mature Fields

• Declining oil production and reservoir pressure
• High Liquid Production → Surface Facility Capacity & reliability, more injection wells
• Need more artificial lift → need more power capacity
• Scale up problem starts from wellbore into Gathering Station → Stimulation, scale inhibitor
• More sand problem occurred, more well intervention activities
• Need more chemicals for liquid processing → demulsifier, scale inhibitor, corrosion inhibitor
Managing Mature Fields

### Mature Field:
- More Liquid Production (Water Cut > 90%)
- Less Oil Production (Declining)
- High Operation Cost

### Need More:
- Surface Facility Capacity (Tanks, Power, Pumps, Separation System etc)
- Injection Wells
- Chemicals needed for liquid processing (demulsifier, scale & corrosion inhibitor)

Managing Strategy to Increase Production
- Infill Drilling
- Outstep Drilling
- Workover and Well Intervention
- Waterflood & EOR
- Surface Facility Reliability
Managing Mature Fields

1. INFILL DRILLING
- Hydrocarbon recovery acceleration.
- New opportunity by looking at low resistivity and thin layer reservoirs.
- Grid base approach for deltaic environment
- Application of advanced drilling techniques: UBD, Horizontal Drilling

2. OUTSTEP DRILLING
- New opportunity to increase production and reserves replacement ratio.
- New seismic and well data acquisition.
- GGRP Studies.

3. WORKOVER / WELL INTERVENTION
- New layers found from drilling activities, new well log data, GGRP studies.
- New opportunity by looking at low resistivity layer, thin layer reservoirs, tight reservoirs.
- Fracturing & well stimulation.

4. EOR / SECONDARY AND TERTIARY RECOVERY
- Secondary Recovery / Waterflood: Studies, Pilot & full scale waterflood at selected fields.
- Tertiary Recovery: Laboratorium Studies, GGRP Study, Field Trial and Pilot at selected fields.

183 Active structures:
- Most of it has been produced before 1970
  - RF Current 26%
  - Np/EUR > 70%

ARE MANAGED THROUGH.....
Success Story: Sangasanga

Reactivation of Suspended Wells
✓ Only 10% from 3100 drilled wells are active wells, either as producers or injectors.
✓ In period 2009 – 2012, 209 wells were reactivated with 34% success ratio.

Lifting Optimization
✓ Lifting optimization through re-sizing SRP from capacity of 200-400 Bfpd into 800-1000 Bfpd.
✓ Lifting optimization contributes the most production gain compares to other well intervention activities.

Development Drilling
✓ Drilling program is made based on recoverable reserves and available space and phase implementation.
✓ Subsurface at East Kalimantan area is commonly deltaic reservoir that has both opportunities & risks with 70% success ratio.

Results:
✓ Maintain and also increase production (sustainable) 101-138%
✓ Infill & step out drilling give additional reserves as much as 11.1 MMBO

Sustainable Production

History of Sangasanga Block

<table>
<thead>
<tr>
<th>Period</th>
<th>Company</th>
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<tbody>
<tr>
<td>1897-1905</td>
<td>NIIHM (Nederlandsch-Indische Industrie en Handel Maatschppij)</td>
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<tr>
<td>1905-1942</td>
<td>BPM (Batavia Petroleum Maatschppij)</td>
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<tr>
<td>1942-1945</td>
<td>Japan</td>
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<td>1945-1972</td>
<td>BPM/Shell/Permina/Pertamina</td>
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<td>1972-1992</td>
<td>TIPCO - Tesoro</td>
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<tr>
<td>1992-2008</td>
<td>PTEN - Medco E&amp;P</td>
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<td>2008-Now</td>
<td>Pertamina EP</td>
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</tbody>
</table>
Success Story: Limau

History of Limau Block

Well Intervention
- Main productive layers in Limau especially Niru and Limau Barat are W, X and Y series
- Reopening upper series such as R and S series which has been suspended

Lifting Optimization
- Optimize Lifting method using ESP and SRP.

Development Drilling
- GGR remodelling with new approach of stratigraphic sequences → Outstep drilling, discovered new pool North side of Niru, new Layer at Limau Barat
- Horizontal Drilling implementation to optimize oil recovery

Results:
- Increase production from 5,895 BOPD to 11,200 BOPD
- Infill & step out drilling results in additional reserves 212 MMBO
Success Story: Prabumulih Barat

Development Drilling
- Based on newly acquired 3D seismic interpretation and GGR re-modelling → new pool discovery at PB series layer of GRM.
- Currently 20 infill and step out wells have been drilled to develop oil and gas reserves in PB Series layer.
- Multi layer completion to save rig cost and strive for efficiency in operation.

Workover & Well Intervention
- 67 workovers and well interventions were executed in 2010 to 2017, mostly in PB series layer to optimize oil & gas production.

Results:
- Increase production from 238 BOPD and 5 MMscfd into 957 BOPD and 36 MMscfd.
- Infill & step out drilling results in additional reserves 4.6 MMBO and 66 BSCF.

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- Increase production from 238 BOPD and 5 MMscfd into 957 BOPD and 36 MMscfd.
- Infill & step out drilling results in additional reserves 4.6 MMBO and 66 BSCF.
Success Story: Rantau Waterflood

- Development Drilling & Workover
  ✓ Drilling Results:
    - 17 production wells and 11 Injection wells
  ✓ Workover & well intervention Results:
    - 20 production wells and 4 injection wells
  ✓ 7 waterflood patterns have been developed at layer Z600
  ✓ Upgrade and repair production and injection facilities: Gathering Station, Water Treatment Plant / Water Injection Plant

Results:
- Increase oil production from 500 BOPD into 1500 BOPD
- Secondary WF PEP Phase is currently resulting in additional oil cumulative production of 2.3 MMBO from total additional reserves target of 20.32 MMBO

<table>
<thead>
<tr>
<th>BLOK</th>
<th>OOP (MMSTB)</th>
<th>Primary Phase Oil Cum (MMBBL) RF (%)</th>
<th>Secondary JAPEX Phase Oil Cum (MMBBL) RF (%)</th>
<th>Secondary PEP Phase Oil Cum (MMBBL) RF (%)</th>
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<tbody>
<tr>
<td>A1</td>
<td>15.7</td>
<td>3.77 24%</td>
<td>0.0 0.0%</td>
<td>0.6 3.9%</td>
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<tr>
<td>A2</td>
<td>10.6</td>
<td>3.57 34%</td>
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<td>0.8 7.7%</td>
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<td>B</td>
<td>7.8</td>
<td>2.98 38%</td>
<td>0.0 0.0%</td>
<td>0.0 0.5%</td>
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<tr>
<td>C1</td>
<td>18.7</td>
<td>7.18 38%</td>
<td>0.0 0.0%</td>
<td>0.5 2.9%</td>
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<tr>
<td>C2</td>
<td>10.4</td>
<td>2.40 23%</td>
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<tr>
<td>D1</td>
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<td>1.39 15%</td>
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<td>0.0 0.2%</td>
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<tr>
<td>D2</td>
<td>13.9</td>
<td>3.73 27%</td>
<td>0.9 6.4%</td>
<td>0.1 0.7%</td>
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<td>D3</td>
<td>10.3</td>
<td>1.96 19%</td>
<td>0.9 8.6%</td>
<td>0.0 0.1%</td>
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<tr>
<td>D4</td>
<td>16.7</td>
<td>2.79 17%</td>
<td>0.4 2.7%</td>
<td>0.1 0.6%</td>
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<tr>
<td>E</td>
<td>15.7</td>
<td>0.26 2%</td>
<td>0.0 0.0%</td>
<td>0.0 0.0%</td>
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<tr>
<td>Total</td>
<td>129.0</td>
<td>30.02 23%</td>
<td>3.6 2.8%</td>
<td>2.3 1.8%</td>
</tr>
</tbody>
</table>
Water Treatment Injection Plant Rantau

WTIP Facility Rantau Before and After Development

Submanifold SP 3 Facility Before and After Development
Production History & Forecast
terima kasih