Integrated Production Modelling in function of Full Field Optimization Programme

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SPE SECTION CROATIA
INA Production Optimization Concept

Production Loss Management Programme (PLMP)

Integrated Production System Analysis Team

Full Fields Optimization Programme (FFOP)

Process Analysis Team

Process Optimization Programme (POP)
INA Production Optimization Concept

**Full Field Optimization Programme**
- Reservoir Performance Improvement
- Well Performance Improvement
- Inflow Performance (Stimulations, Sand Control)
- Vertical Lift Performance (Artificial Lift Optimization, Velocity String installation, WH Pressure manipulation)
- Flow Assurance (Wax, Scale, Corrosion inhibition improvement)
- Pipeline Network Performance Improvement
- Flow Assurance (Smart Pig, Wax, Scale, Corrosion inhibition improvement)
- Reconstruction due to performance improvement
- Facility Performance Improvement
- Integrated Production System Computer Models - Maximum system production potential determination

**Process Optimization Programme**
- During the oil/gas field lifecycle, all parameters in the produced wellstream change; composition, flow, pressure, temperature….
- Process plants require constant modification in order to meet the new characteristics of the feed.
- Inlet separation – review of the plant metallurgy/corrosion performance, separator sizing, pressure/temperature of operation.
- Gas compression – constant adjustment of compression plant capacity. Intention to build the compressors only when needed, not too much in advance. Use of existing compressor machines. Relocation from a depleted field to a new location. Re-use and re-engineering of the existing equipment.
- Gas sweetening. Update of the sweetening technology, plant revamps in order to achieve lower energy consumption and other benefits of the change of sweetening technology. Meeting the new feed requirements - general trend of increase of sour gasses content in the produced gas.
- NGL recovery and fractionation. Rereview of NGL plant operation modes and maximizing the profit from NGL.
- Utilities – optimization of cogeneration plants’ operation; balancing the production of el. power and heat.

**Production Loss Management Programme**
- Maximum system production potential determination from Integrated System Computer Models
- Actual production is to be monitored and any gap between actual production and the potential becomes loss (Production data monitoring, capturing and recording to be improved for better system surveillance)
- Losses must be recorded, classified and losses also must be allocated back to wells as it is done for production allocation.
- Production efficiency & Operational efficiency determination
- Management process : a) Capture loss event, b) Validate, Quantify & Classify event, c) Investigate the loss event, d) Review and Action
- To facilitate the prioritization of action list, it is necessary to evaluate the loss in terms of HSE impact, financial / commercial impact, volume impact and any cost in performing maintenance /work-over operations
- Repeated maximum system production potential determination (System Analysis)
INA Cluster (Technological Unit) Schematics

- 8 FFO Clusters
- 2 POP
- 10 PLMP

FFO – FULL FIELD OPTIMIZATION PROGRAM
POP – PROCESS OPTIMIZATION PROGRAM
PLMP – PRODUCTION LOSS MONITORING PROGRAM
PM – PROJECT MANAGER
AC – AUTO CISTERNA
M – MJERENJE
INTEGRIRANI PROIZVODNI SUSTAV POLJA
MAKSIMALNI PROIZVODNI POTENCIJAL – INTEGRIRANI PROIZVODNI MODELI POLJA
**Oil field Ilača**

- Number of hydrodynamic units: 2 (1 depleted)
- Number of producing wells: 5 (93 boepd)
- OOIP / RFc: 1 Mm3 / 26%
- Initial / current reservoir pressure: 110 bar / 53 bar
- Current WC & GOR: 38% & 168 m3/m3
- Artificial Lift: Sucker-rod lift
- Dominant drive mechanism/s: Gas cap + depletion

**Oil field Privlaka**

- Number of hydrodynamic units: 5 (2 inactive)
- Number of producing wells: 11 (579 boepd)
- OOIP / RFc: 3.8 Mm3 / 27.3%
- Initial / current reservoir pressure: 76-101 bar / 76-96 bar
- Current WC & GOR: 61% & 57 m3/m3
- Artificial Lift: Sucker-rod lift
- Dominant drive mechanism/s: Bottom or edge water

**Oil field Đeletovci**

- Number of hydrodynamic units: 2 (1 depleted)
- Number of producing wells: 26 (1900 boepd)
- OOIP / RFc: 6.2 Mm3 / 46.6%
- Initial / current reservoir pressure: 103 bar / 88 bar
- Current WC & GOR: 32% & 53 m3/m3
- Artificial Lift: Sucker-rod lift
- Dominant drive mechanism/s: Bottom water
Goal of Programme Đeletovci Cluster

13 WWOs (NFN-15 & Additional development of Đeletovci – Phase 1):
Đt-5, -8, -9, -11, -14, -24α, -37, -39, -41, -42, -45, Ila-16 i Pri-16α

5 WWOs (NFN-14):
Đt-22, -28, -32, -45 i Pri-17

Production optimisation of 18 wells (NFN-15)

+ 1396 BOE/d (+119%)

Additional 540 boepd of HC will be in production after realization the project „Additional development of the Đeletovci, Ilača and Privlaka oil and gas fields – Phase 2” in 2019. Also, according to reinterpretation of 2D seismic profiles and well logs, confirmation of new gas reserves (reservoirs) are expected as part of the project in 2018.

• Question: Are there bottlenecks that could limit the further increase in hydrocarbon production in the future?
**Integrated Production System Model – Đeletovcı Cluster**

**FFOP** - Integrated approach based on fields cluster (technological units) nodal analysis

- Production System Potential Determination present / future
- Production Optimization – Bottlenecks Shooting;
- Production Allocation (Production Loss Mng. P.);

### Reservoir - MBAL

- HISTORY MATCHED, DECLINE

### Wells

- **Prosper**
  - **IPR**
    - VOGEL, MULTIRATE JONES/VOGEL
  - **VLP**
    - PETROLEUM EXPERTS I; II; III

### GatheringSys - GAP

- PETROLEUM EXPERTS V, Brill (slugs)

### Fluid Data

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<th>Fluid</th>
<th>31.7.2016.</th>
<th>IPM</th>
<th>Diff</th>
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<td>Ql (m³/d)</td>
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<td>Qo (m³/d)</td>
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<td>Qw (m³/d)</td>
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<tr>
<td>Qg (m³/d)</td>
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<td>18 992</td>
<td>5,3%</td>
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Prerequisites for the use of material balance (MBAL) method:

- All fluids taken from or injected into the reservoir be measured accurately.
- Pressure, volume, and temperature characteristics (PVT properties) be measured and validated.
- At least one static pressure from each well prior to production and several after production has commenced are required to achieve good results.
- Material balance can be applied when about 20% of the initial estimated reserve is produced, or when 10% of initial reservoir pressure has declined.

Pressure history match was obtained by adjusting the parameters of the aquifer.

Example: Oil field Deletovci
• MBAL is a powerful tool that helps determine the reserves, recovery factor, and drive mechanism.

• Identifying the drive mechanism is important for development strategy and ultimate recovery.
The relative permeability curves were determined on the basis of production data, by matching the fractional-flow curves, performed for each individual tank (hydrodynamic unit) and well separately.

Inflow performance curves were generated using Vogel’s equation.

VLP correlation is based on SRP equipment and pressure/temperature drop thru tubing

→ Used method provides estimating of future production behavior for each individual well.

MBAL method/model can be replaced with 3D simulation (numerical) model in the future. Also, well production profiles can be generated by decline curves analysis (DCA) method.

Examples: Oil field Deletovci
• Current water disposal pump capacity-380 m³/d **BOTTLENECK!**
• Additional water injection capacity needed to conduct maximum production
• Pipeline flow regime problems (emulsion, slug flow and paraffin deposition)
EOR Ivanić - Existing Reservoir model is not combined with surface GAP model and without bottlenecks. With integration of these models it is possible to predict bottlenecks in surface equipment to act proactive and to remove them to achieve maximum production potential from reservoir.