

Multiwell Retrospective Testing

1. Synopsis

Multiwell Retrospective Testing (MRT) is a workflow aided by the PolyGon software, which is based on the correlation between long-term bottomhole pressure and flow rate histories of several wells.

It helps to determine if the wells are draining the same reservoir, if they are situated in the same compartment, if there is any sign of unplanned cross-reservoir communication in generating or offset wells (due to borehole cross-flow or behind-casing channelling), and checks the extension, conductivity, and proximity of the faults, as well as the lateral direction and extension of hydraulic fractures. MRT also provides numerical values of cross-well connectivity for the calibration of full-field geological and dynamic modeling.

This is an in-office production/injection history study, which normally takes around one month for a conventional MRT cell (involving 5 to 10 wells).

MRT heavily relies on computer-aided automation, which has made the service reasonable in terms of turn-around-time.

MRT substantially relies on the availability of the long-term downhole permanent pressure gauge data. It also requires reliable rate tests and/or reallocated rate history for automatic reconstruction of continuous historical rate records that align with pressure history.

MRT utilizes a machine learning approach to perform production analysis based on multiwell deconvolution to generate the final deliverables.

Using a multi-well pressure deconvolution technique, it estimates potential drainage volumes, boundary types, their proximity, reservoir transmissibility, and cross-well connectivity, thus substantially enhancing the conventional single-well PTA/RTA.

The process reconstructs the history of formation pressure and the productivity index history.

The MRT workflow includes the procedure of reconstructing the history of formation pressure and productivity index. This provides numerous constraints for future reservoir modeling.

Furthermore, it helps in selecting underperforming wells for workover and/or additional surveillance activities.

Multiwell Retrospective Testing

2. Engineering Domain

- Reservoir study
 - Subsurface cross-well connectivity
 - Well-by-well production history analysis
 - Pressure/Rate Transient Analysis
 - Formation characterization

3. Target Consumers

- Reservoir Engineers
- Simulation Engineers
- Geologists/Petrophysicists
- Production Technologists
- Well Test Analysts

4. Key Product Deliverables

- Cross-well connectivity (quantitative)
- Tested Well Formation Pressure History Analysis
- Tested Well Productivity History Analysis (factual against expectation)
- Short-term Production Forecasts
- Thief water production suspects (quantitative appraisal)
- Thief water injection suspects (quantitative appraisal)

5. Key Advantages

- Extract new information about wells and reservoirs from the already available production/pressure history
- Fast & highly automated heavy data processing
- Highly automated production history analysis based on machine learning

6. Data Outputs

Tested Well:

- Reconstruction of Formation Pressure history (continuous records)
- Reconstruction of Productivity Index history (continuous records)
- Production rate and Formation Pressure short-term forecasts based on user-defined future BHP scenario
- BHP and Formation Pressure short-term forecasts based on the user-defined future Production Rate scenario
- Potential drainage volumes
- Boundary type
- Boundary proximity
- Reservoir transmissibility
- Well-Reservoir Contact (skin-factor, fracture half-length, horizontal length, number of active frac zones)
- Well-bore storage
- Quantitative estimation of thief water production (if any)

Offset wells:

- Cross-well connectivity history (absolute historical values and unit-rate values)
- Cross-well connectivity maps (absolute historical values and unit-rate values)
- Quantitative estimation of thief water injection in offset wells (if any)

7. Data Inputs

General:

- PVT model (FVF, compressibility, viscosity for oil/gas/water)
- Pore compressibility
- Additional Data for Comparative Study of MRT Results Against Rock Properties:
 - Relative Permeability Model
 - Reservoir Thickness Map

Tested Well:

- Production rate tests (historical records)
- Reallocated monthly (oil/gas/water) production rate history (if available it may improve the rate reconstruction due to cumulative constraints)
- Long-term Permanent Downhole Pressure Gauge (PDG) history records (normally > 6 months but may depend on the data sampling and accuracy)
- Well Intervention History
- Reservoir thickness, porosity, permeability (only required for comparative analysis of MRT results vs expectations)

Offset wells:

- Production rate tests (historical records)
- Reallocated monthly (oil/gas/water) production rate history (if available, it may improve the rate reconstruction due to cumulative constraints)
- Well Intervention History
- Reservoir thickness, porosity, permeability (only required for comparative analysis of MRT results vs expectation)

8. Service facilities and procedures

- Office work:
 - High performance multi-core workstation
 - Polygon software facility

9. Service duration

- Normally one month for one MRT cell with 5 to 10 wells and up to 30 years production history

10. List of technologies used

- Multiwell Deconvolution (based on PolyGon MDCV 4.0 module)
- Automated Production History Analysis (based on PolyGon PRIME module)