APPS 2018
ASIA PACIFIC PERFORATING SYMPOSIUM

PROPELLANT-ASSISTED STIMULATION SUCCESS IN INDIA (using StimGun™) A CASE STUDY

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BAKER HUGHES
a GE company

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AUTHOR: Aditee Kulkarni

Baker Hughes, a GE company

PROPELLANT-ASSISTED TREATMENT

PROPELLANT-ASSISTED STIMULATION TREATMENT -A CASE STUDY IN INDIA

- Field Description & Objectives
- Well History
- Petrophysical Analysis
- Challenges and recommendations
- Dynamic Event Simulation - Object II
- Production performance of Object II
- Dynamic Event Simulation - Object III
- Production performance of Object III
- Observations and Conclusions

FIELD DESCRIPTION & OBJECTIVES

A FIELD IN NORTH-EAST INDIA

- An Exploratory well in North-East Indian field was drilled to explore the formation.
- Based on the integrated study of geological and geophysical data, four objects were approved for initial production testing.
- All objects were in the same formation.
- This sandstone formation has 12 % porosity, 60% water saturation and 1-5 mD permeability, with high stress magnitude (~0.75 psi/ft).
- The objective of the testing was to identify fluid type, flow rate and pressure data to build a rich reservoir model.

WELL HISTORY

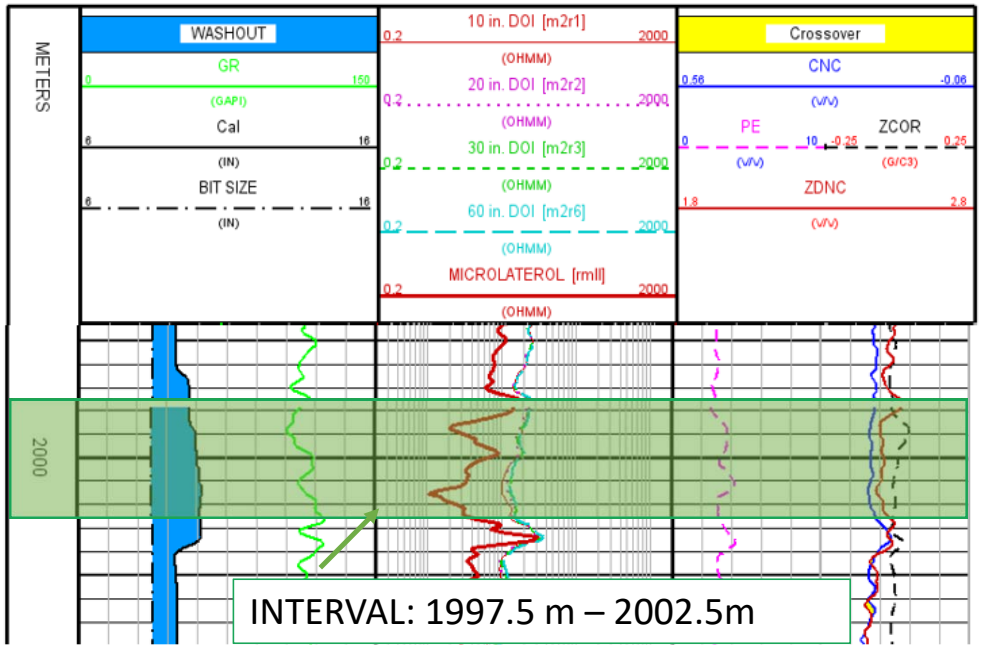
OBJECT I- CONVENTIONAL PERFORATION

- INTERVAL- 1997.5m – 2000m
  1st compressor application-100 KSC – No surface activity- CHP/THP=0 psi
  2nd compressor application-140 KSC – No surface activity- CHP/THP=0 psi
  3rd compressor application-165 KSC –mild gas flow- FTHP=0, SCHP= 80 psi
  4th compressor application-132 KSC – No surface activity- CHP/THP=0 psi

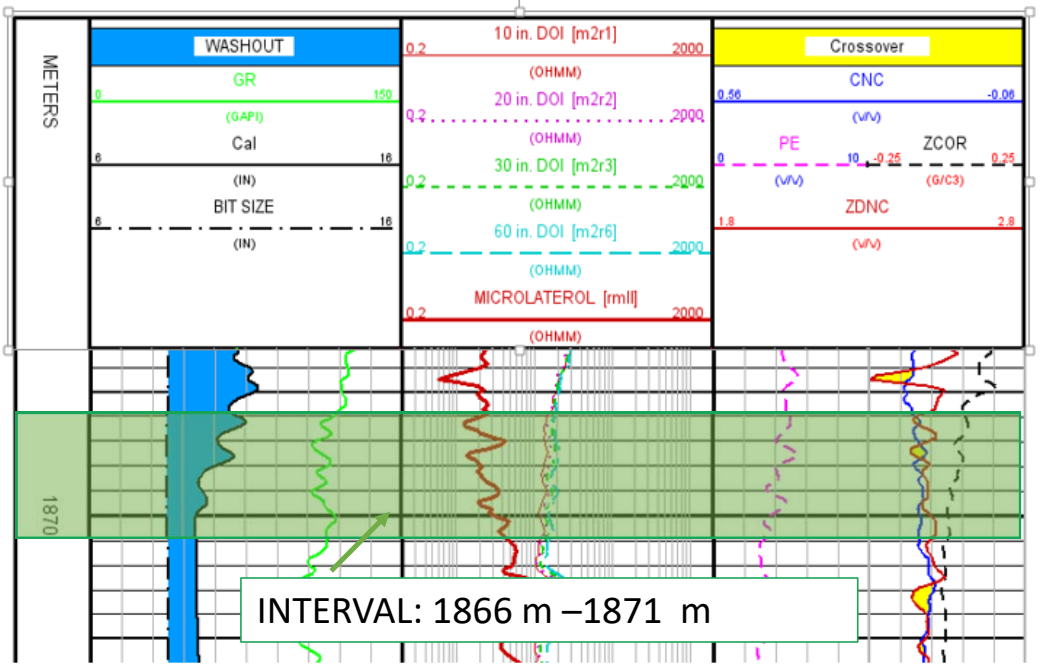
- INTERVAL- 2000m – 2002.5m
  1st compressor application-100 KSC – No surface activity- CHP/THP=0 psi
  2nd compressor application-150 KSC – No surface activity- CHP/THP=0 psi
  3rd compressor application-159 KSC –No surface activity- CHP/THP=0 psi
  4th compressor application-24 KSC -No surface activity- CHP/THP=0 psi

PETROPHYSICAL ANALYSIS

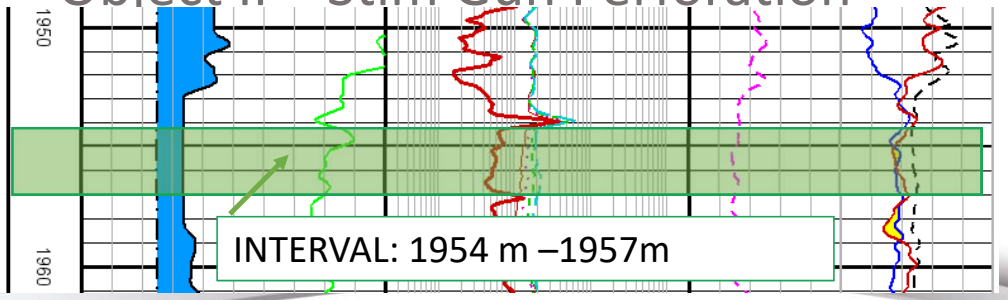
Object I- Conventional Perforation



Object III – Stim Gun Perforation



Object II – Stim Gun Perforation



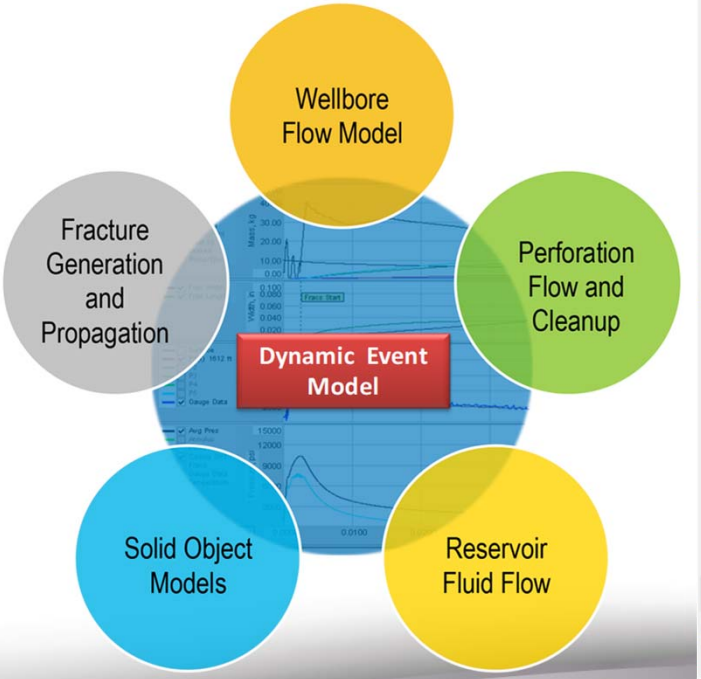
CHALLENGES AND RECOMMENDATION

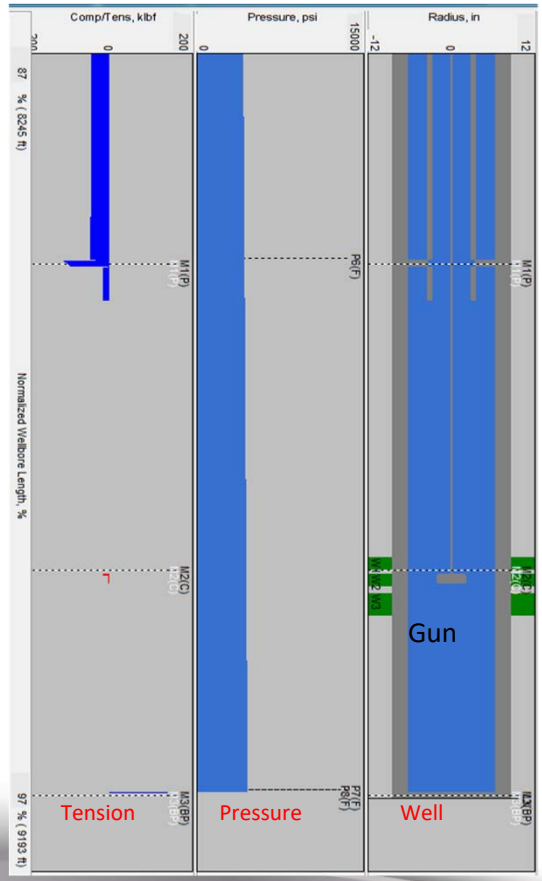
- Overbalanced perforations with wireline were required, so as to test many objects in the same well without lowering the completion string
- Low permeability did not provide good perforation clean-up.
- With conventional perforation, the expected flow could not be achieved due to the possible presence of skin factor.
- The challenge was to overcome the near wellbore damage in order to connect the wellbore with uninvaded formation.
- **Propellant-assisted technology** was recommended to penetrate near wellbore damage, reducing skin and mildly stimulating the well.

DYNAMIC EVENT SIMULATION

- Scientific platform capable of simulating short-time (0.5-tens of seconds) dynamic events, widely used over the last 20+ years.

- Applications include:
  - Dynamics of perforating events
  - Propellants
  - Underbalance mechanisms
  - Tunnel Clean-up
  - Shock modeling
  - Risk Mitigation





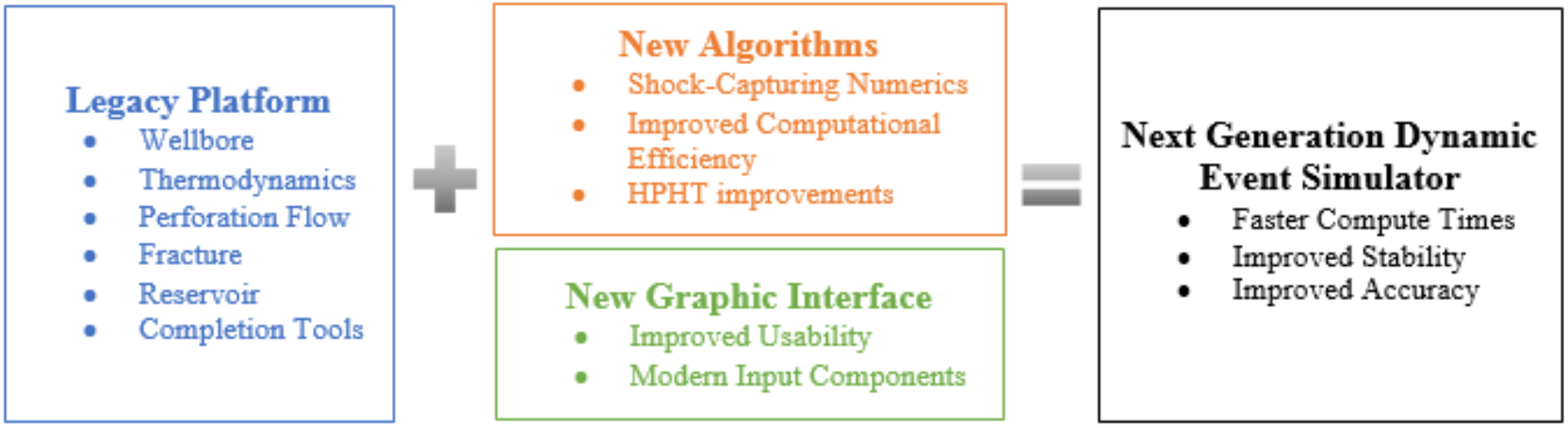
NEXT-GEN DYNAMIC EVENT SIMULATION

Integration of new physics and numerical algorithms

- New wellbore flow model developed and implemented
- Shock-capturing Riemann-based hydrodynamic solvers incorporated
- Improved fluid thermodynamic closure

A new graphical user interface with a modern look and feel

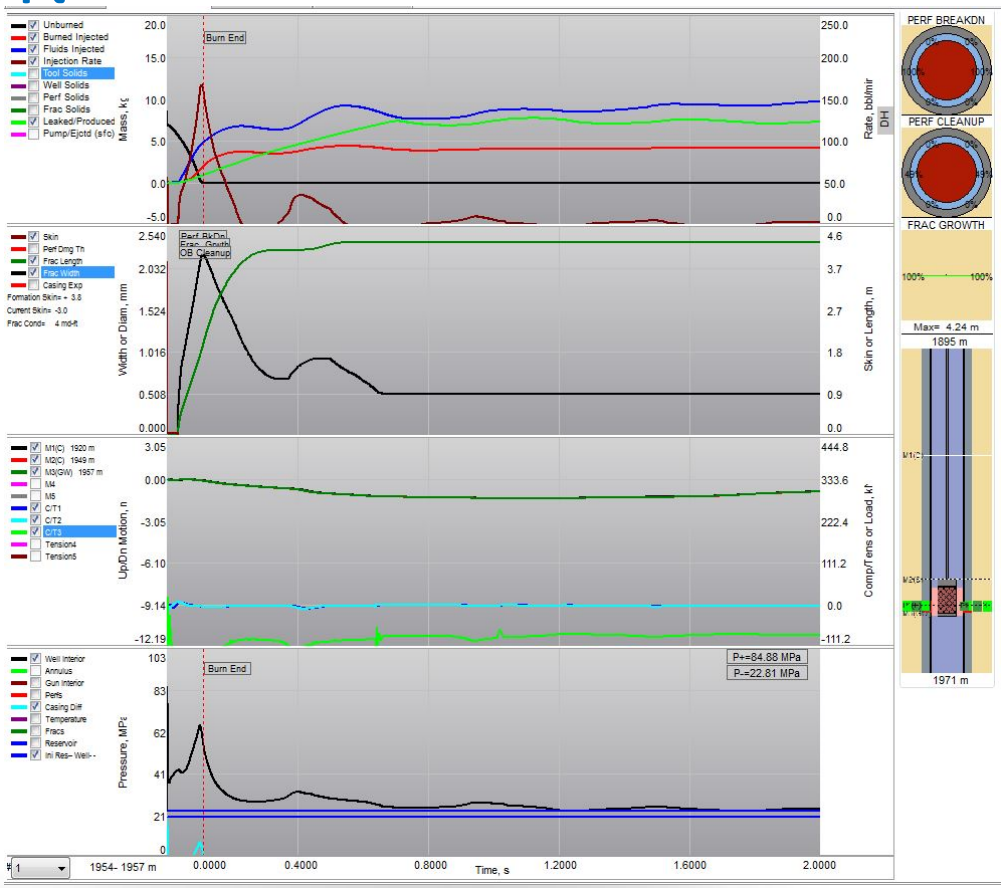
- Updated input forms and software controls
- Simplified user input
- Automated report generation



DYNAMIC EVENT SIMULATION

OBJECT II

- The model assumed an initial positive skin of 3.8 and 5 mD permeability.
- Model results estimate
  post treatment skin of -3,
  100% perforation break down,
  bi-wing fractures ~4.24 m in length,
  fracture conductivity index of ~4mD/ft
- No warnings or flags were observed.



PRODUCTION PERFORMANCE

OBJECT II

- 1st compressor application-100 KSC- The well became active.

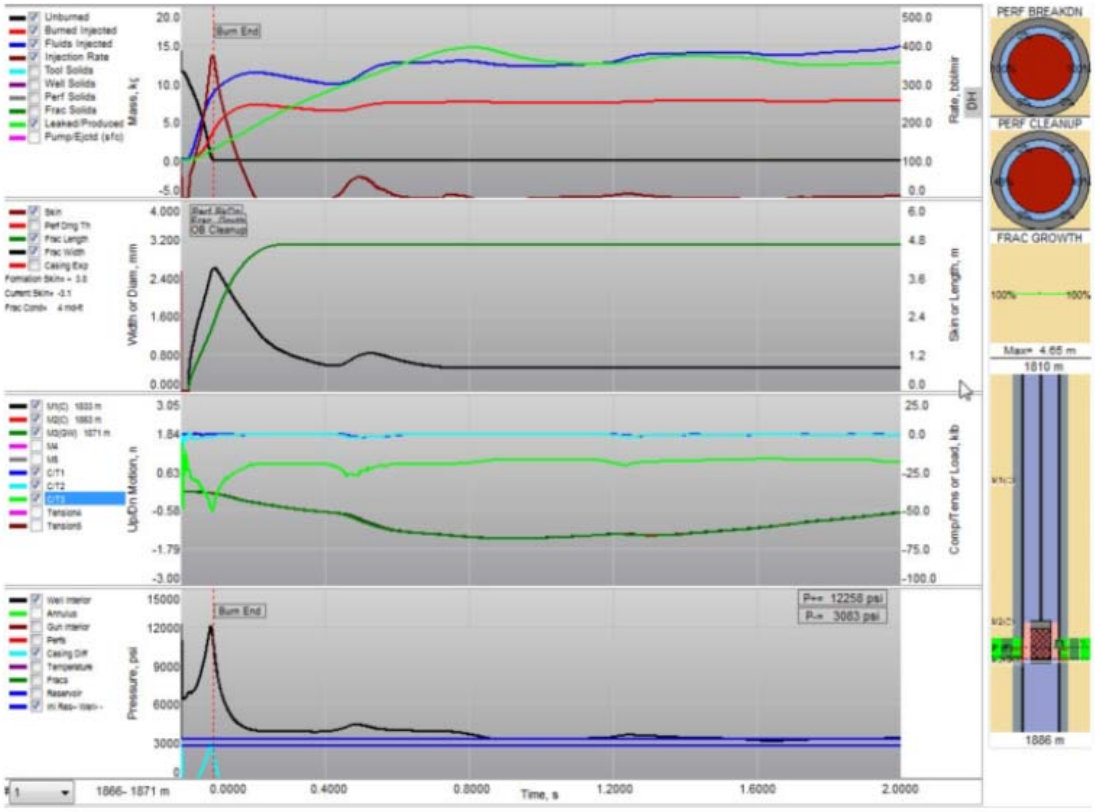
- 8mm bean- Gas along with muddy water flowed with flare height up to 15ft
  4mm bean- The well flowed only gas at first followed by gas with light oil/condensate
  5mm bean- Gas with light oil/condensate was observed to flow continuously
  THP= 370psi, SCHP=600psi, Flare height= 15-18ft

- PLT Results-
  3mm bean: 7146m3/day.
  4mm bean: 9536m3/day.
  5mm bean: 14093m3/day.

DYNAMIC EVENT SIMULATION

OBJECT III

- The model assumed an initial positive skin of 4.2 and 2 mD permeability.
- Model results estimate post treatment skin of -3.1, 100% perforation break down, bi-wing fractures ~4.65 m in length, fracture conductivity index of ~4mD/ft
- No warnings or flags were observed.



PRODUCTION PERFORMANCE

OBJECT III

- 1st compressor application-100 KSC- The well became active.
- Flowing gas continuously through 3mm bean @ 2084 m3/day along with water intermittently@ 1.2 m3/day.
- Well is kept closed for build-up study for PLT job.
- Operational Forecast: PLT job

OBSERVATIONS AND CONCLUSIONS

- With conventional perforation in object I, no flow could be established. gas indication was observed.

- With propellant-assisted application in object II & III, Detailed reservoir studies were carried out and the following parameters were measured.
  - Initial reservoir pressure in shut-in condition.
  - Bean study through 3,4 and 5mm beans under flowing conditions.
  - Fluid properties like API gravity, Density, Water cut etc.
  - Final build-up study in shut-in condition.

- Hence the objective of testing the formation was achieved with the application of propellant-assisted technology, as near wellbore damage was treated by reducing skin and mildly stimulating the well.

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QUESTIONS?
THANK YOU!

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AUTHORS: Dominic Wong, Graham Fraser, Tullow Oil, Noma Osarumwense, Baker Hughes
Rajani Satti, Baker Hughes