

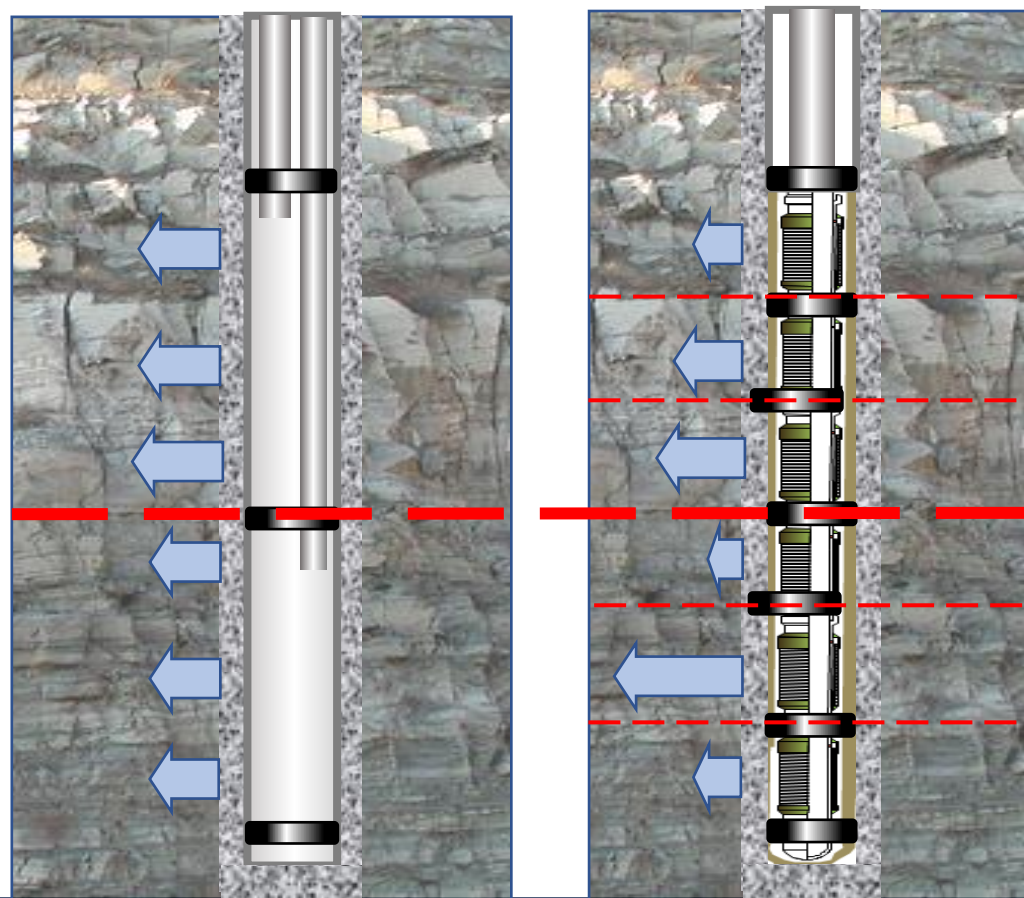
Performance Evaluation of FloFuse, Autonomous Outflow Control Device, in Injection Wells, Field Data Review of Technology Deployments

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TAQA



Common Challenges & Objectives

From Multiple Completions to Single Advanced Completions



Objectives

- ❑ Permit higher resolution control of injection
- ❑ Minimize the impact of rock heterogeneity and anisotropy
- ❑ Ensure proportional distribution of injection
- ❑ Respond to dynamic changes in fluid injection
 - Fracture growth
 - Thermal fracture initiation
 - Matrix impairment, plugging
 - Unexpected variations in fluid displacement
 - Breach in Containment

Solutions

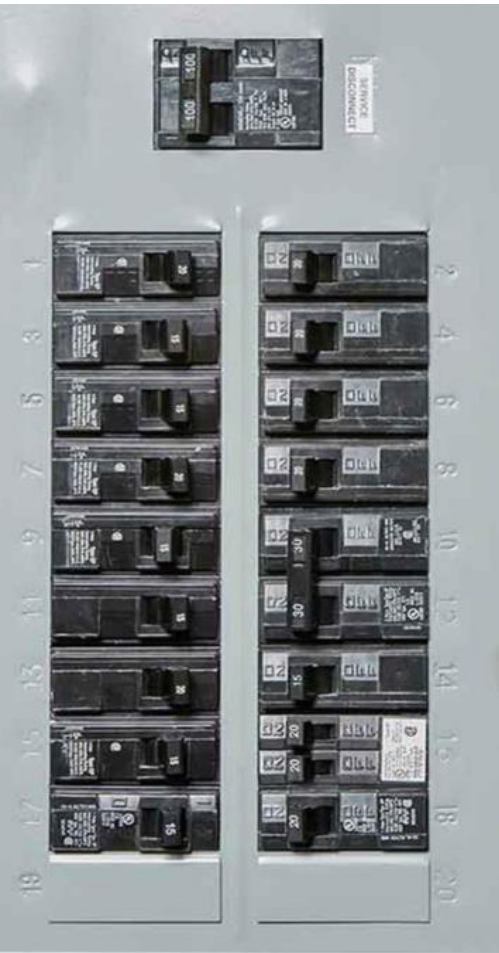
- ❑ Advanced Completions
 - Flow Control Devices: FCDs, **AFCDs**, ICVs
 - Zonal isolation: Packers, seal bores



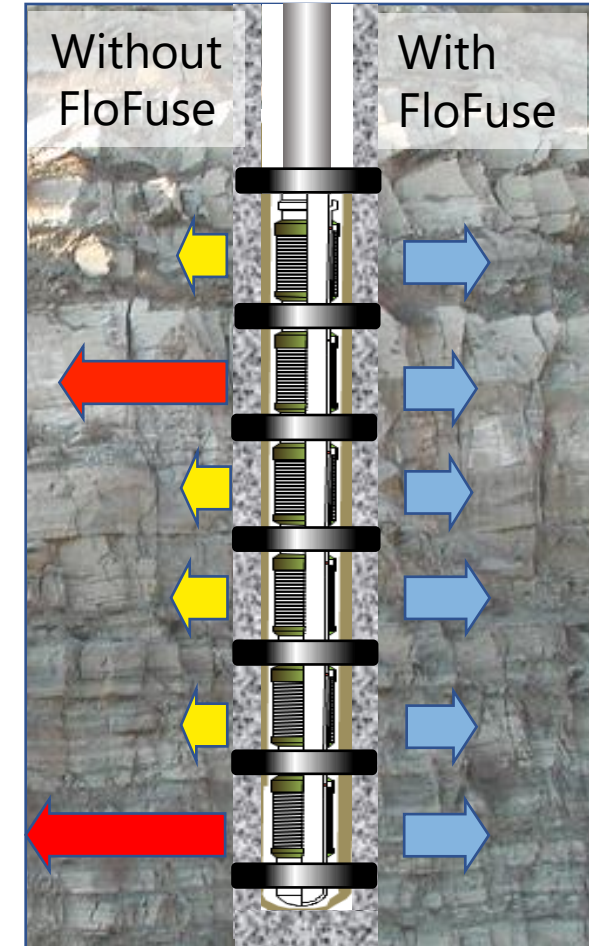
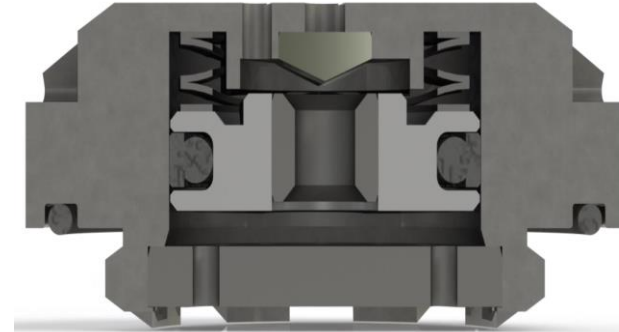
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Design and Operation



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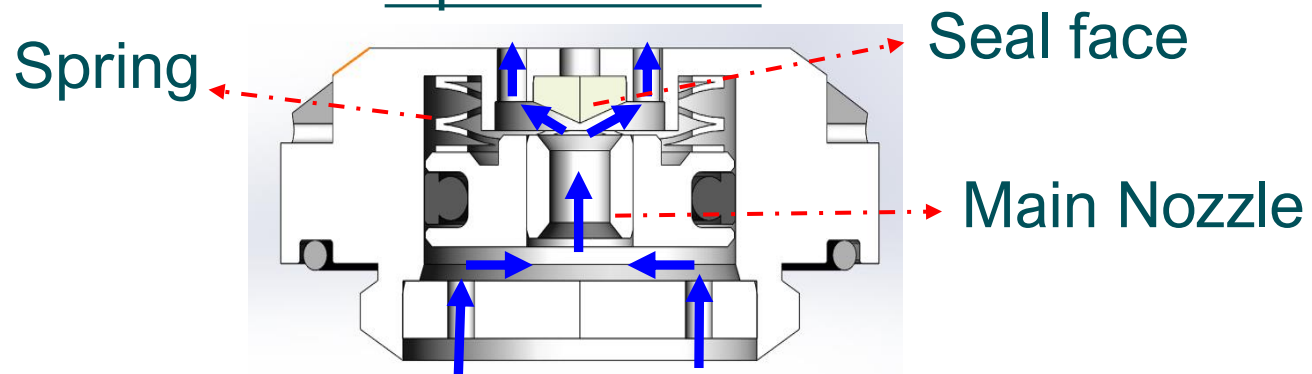


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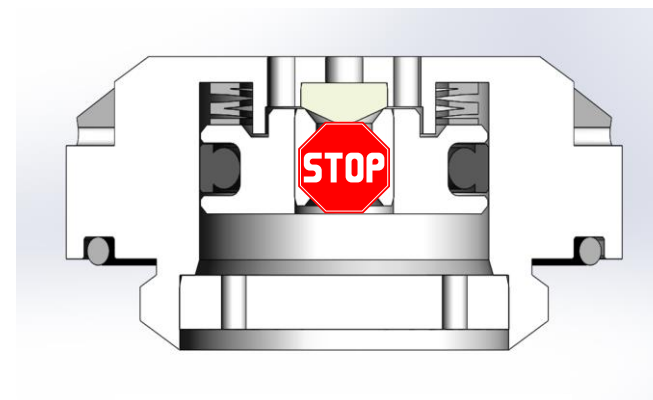


Design and Operation

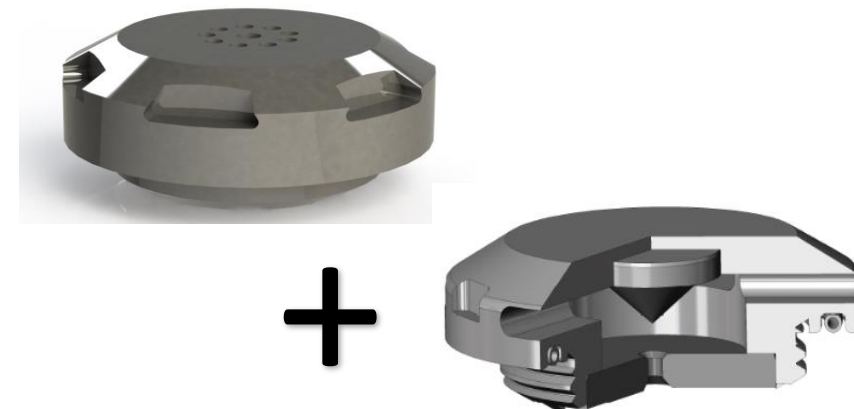
Open to Flow



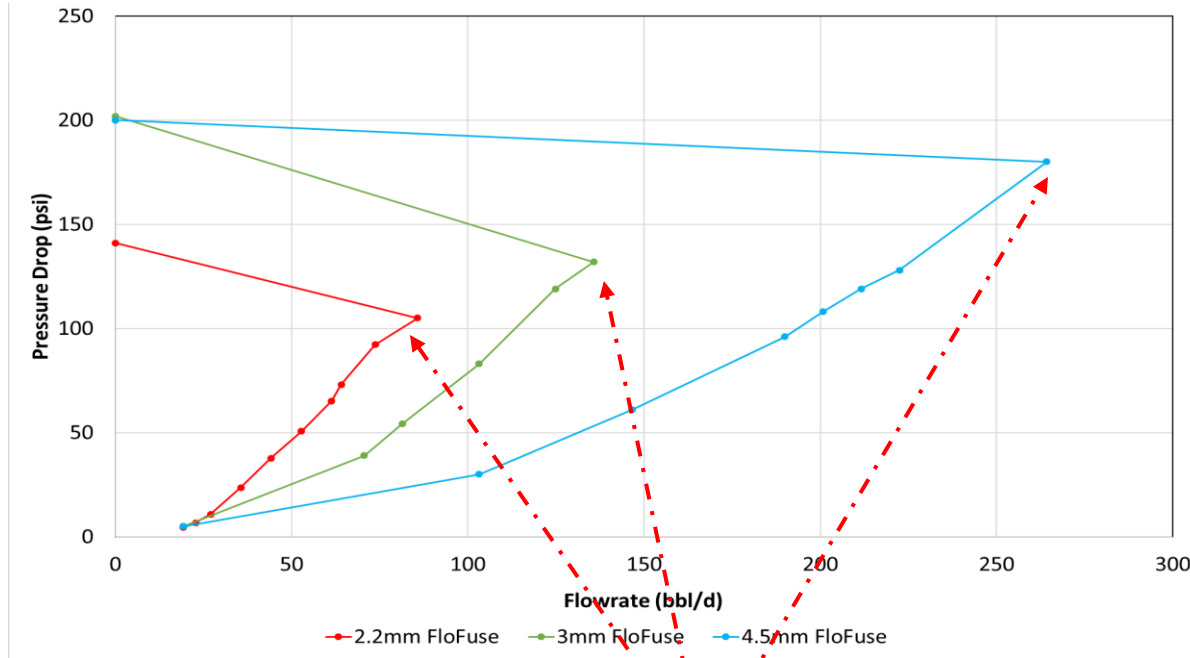
Tripped, Close



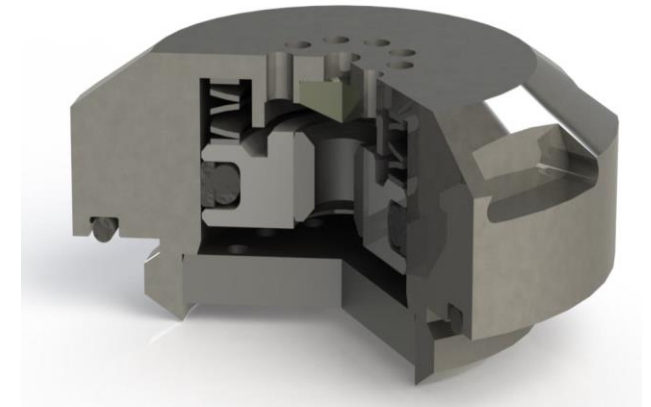
- ❑ The well should be segmented into multiple zones with one or more FloFuse valves within each zone.
- ❑ The valve is mounted into the basepipe or screen section.
- ❑ Majority of fluid passed through FloFuse valves.
- ❑ Bypass valves (size from 1.5mm to 10mm) are to enable injecting a minimum rate to each zone.



Design and Operation



Tripping Pressure (Rate)

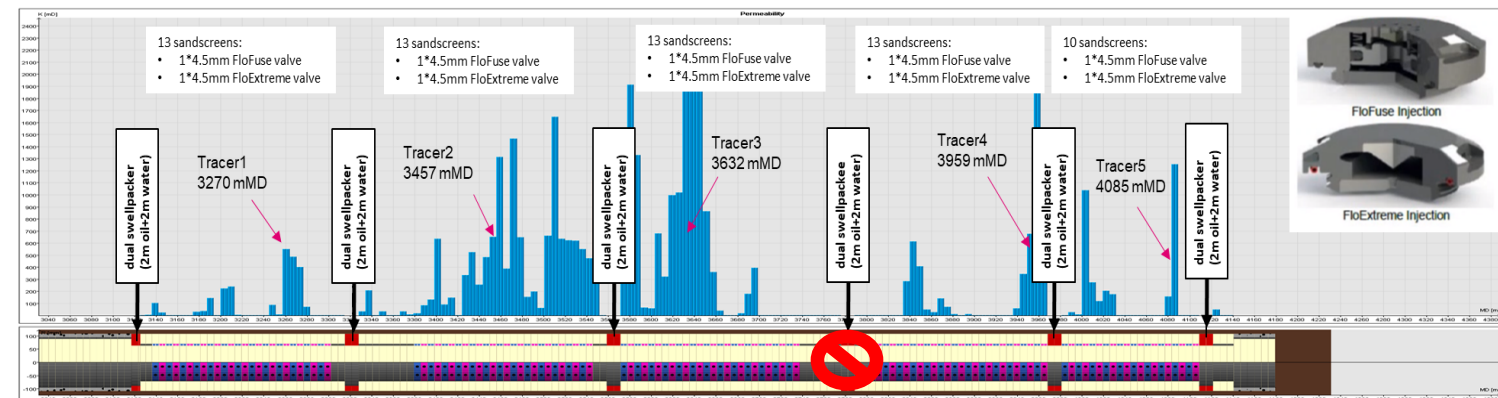
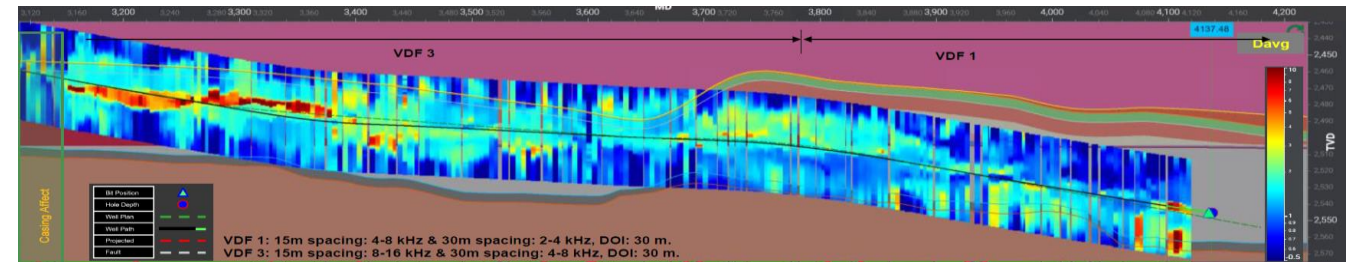
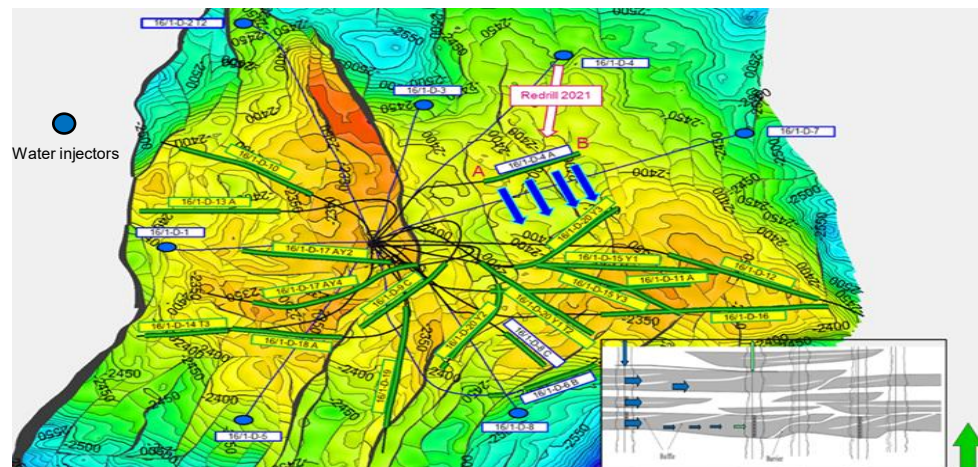


$$\partial P = \left(0.5 * \frac{\rho}{Cd^2 A^2} \right) Q^2$$

Case Study 1

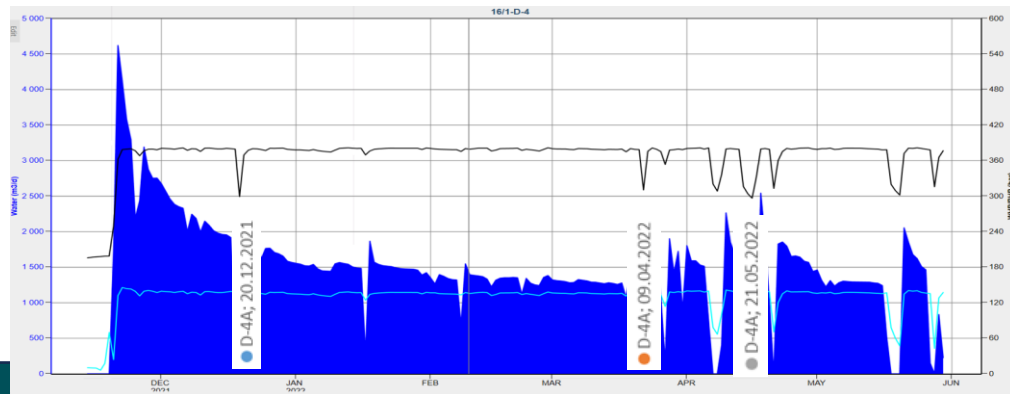
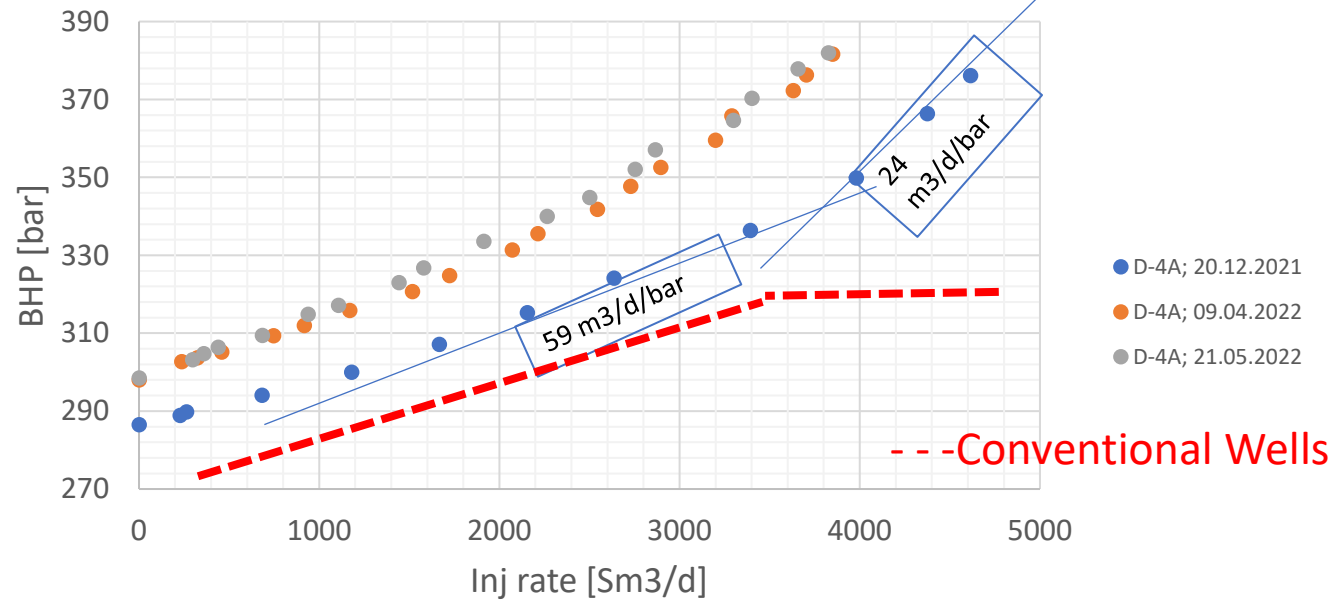
SPE-218473-MS

- Horizontal producers – spread out
- Horizontal water injectors located at the flanks
- Reservoir depletion strongly supported by water injection
- Pushing the oil towards the producers
- Thief zones impact and injection conformance is key for above.



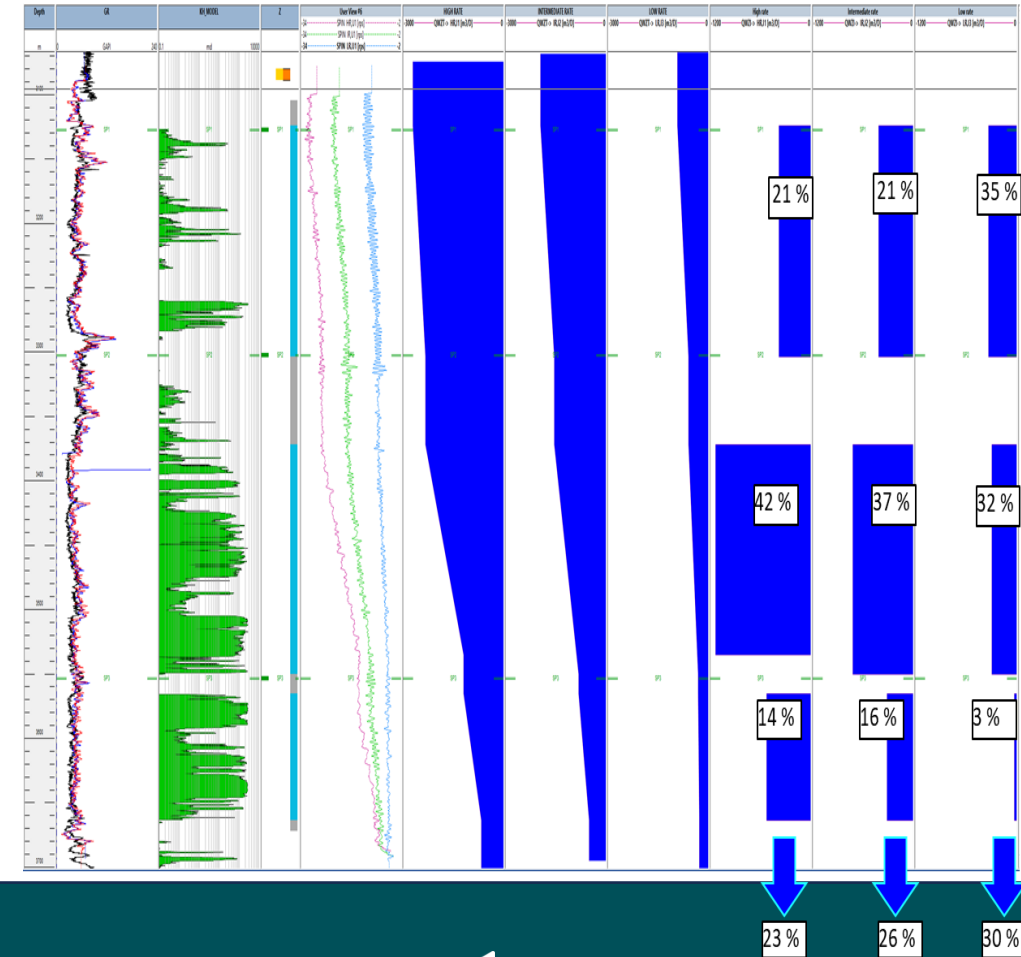
Case Study 1

SRT D-4 A



ILT at:

- high rate (2800 m³)
- mid rate (2000 m³)
- low rate (1000 m³)

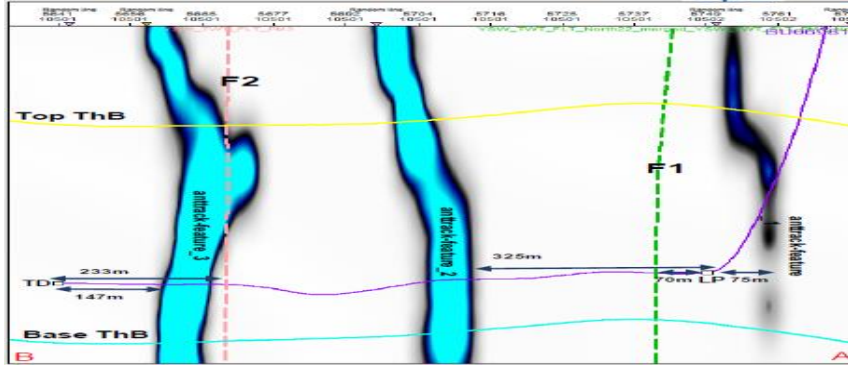


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Case Study 2

SPE-207647-MS



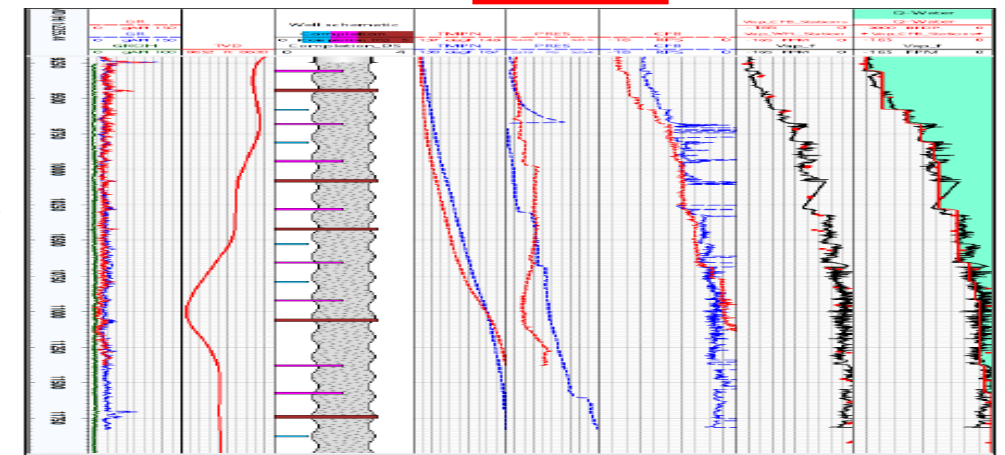
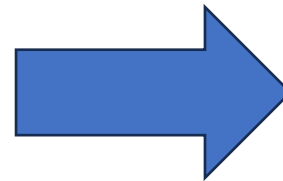
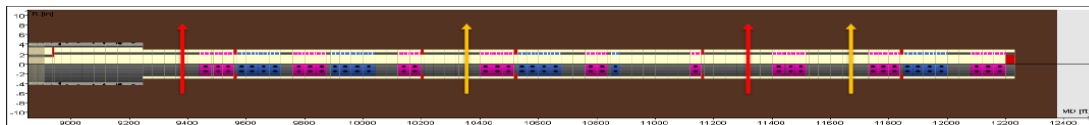
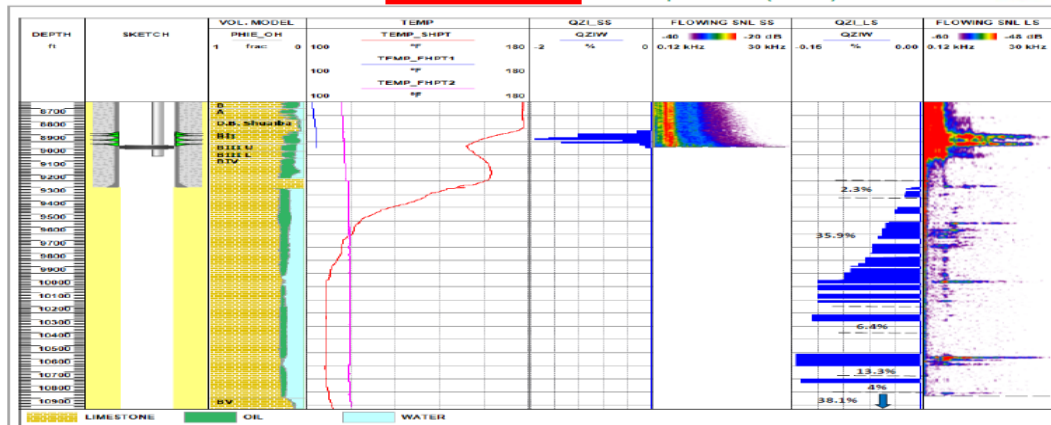
PLT 2014

Challenge:

- two faults and Ant-tracks (fractures/faults with huge properties uncertainty)
- >50% injection goes to thief zones.

Achieved: 42% less injection in thief zones & increase of 20-25% in the other zones & Increase swept along the well

PLT 2021



Zone1

Zone2

Zone3

Zone4

Zone5

Zone6

Features

Fault 1

Ant-track 2

Fault 2 & Ant-track 3



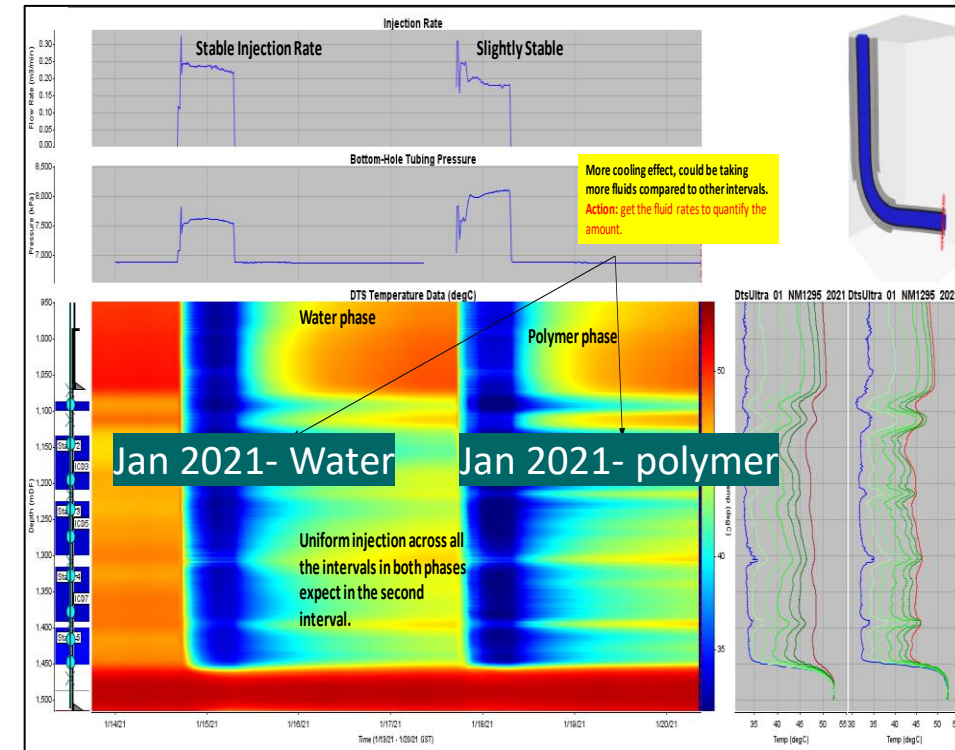
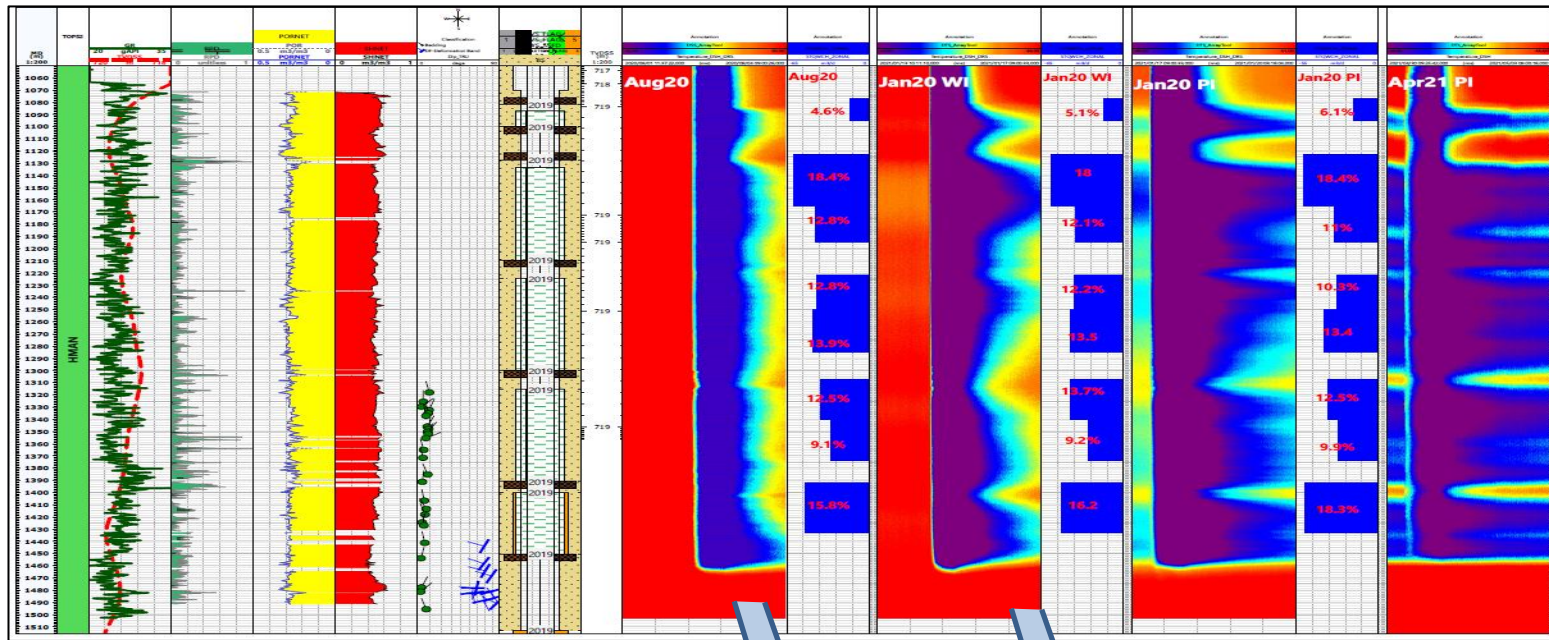
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Case Study 3

SPE-207361-MS

- **Water/polymer** horizontal injection well
- DTS attached to the FloFuse completion

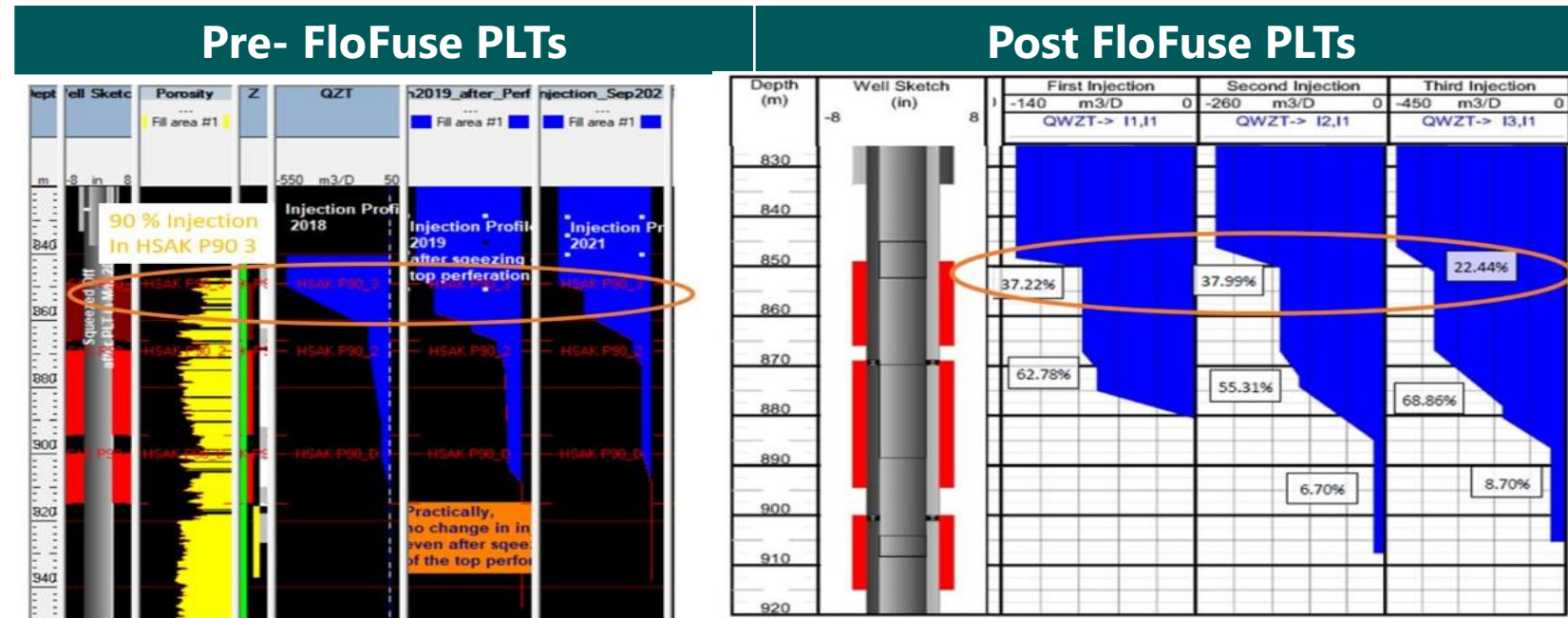


92% of the planned conformance

Case Study 4

SPE-222323-MS

- Vertical water injector drilled in 2017 with three perforations.
- Injection target of 500m³/d to support production wells.
- Sudden increase in the WC in the nearby oil producers after injection.
- Multiple PLTs over years.
- PLT in June 2018 showed more than 90% injection going to top perforation.
- WSO in June 2019 but the follow up PLT showed WSO was unsuccessful as the top perforation was still taking more than 90% of water.



Results

Top perf: from 90% to 22%

Mid perf: from 8% to 69%

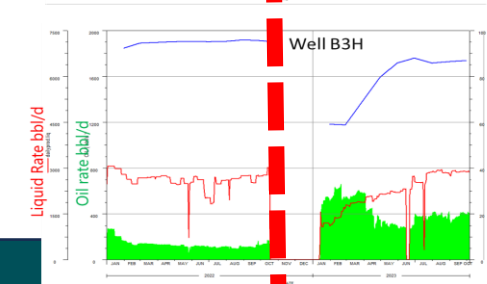
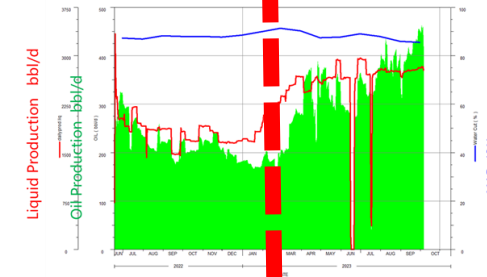
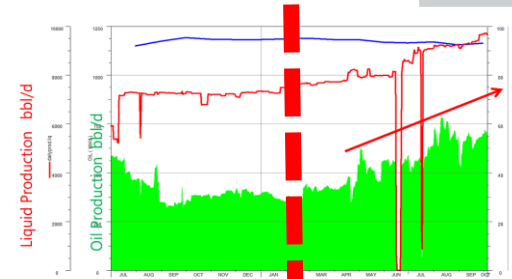
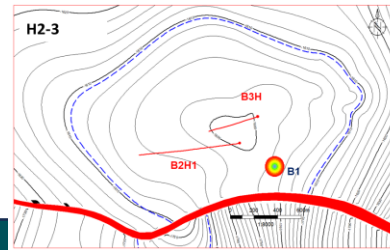
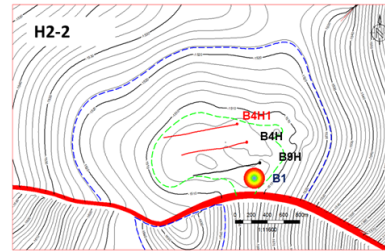
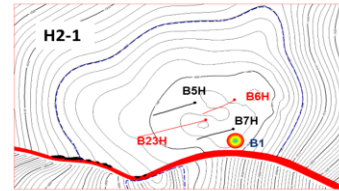
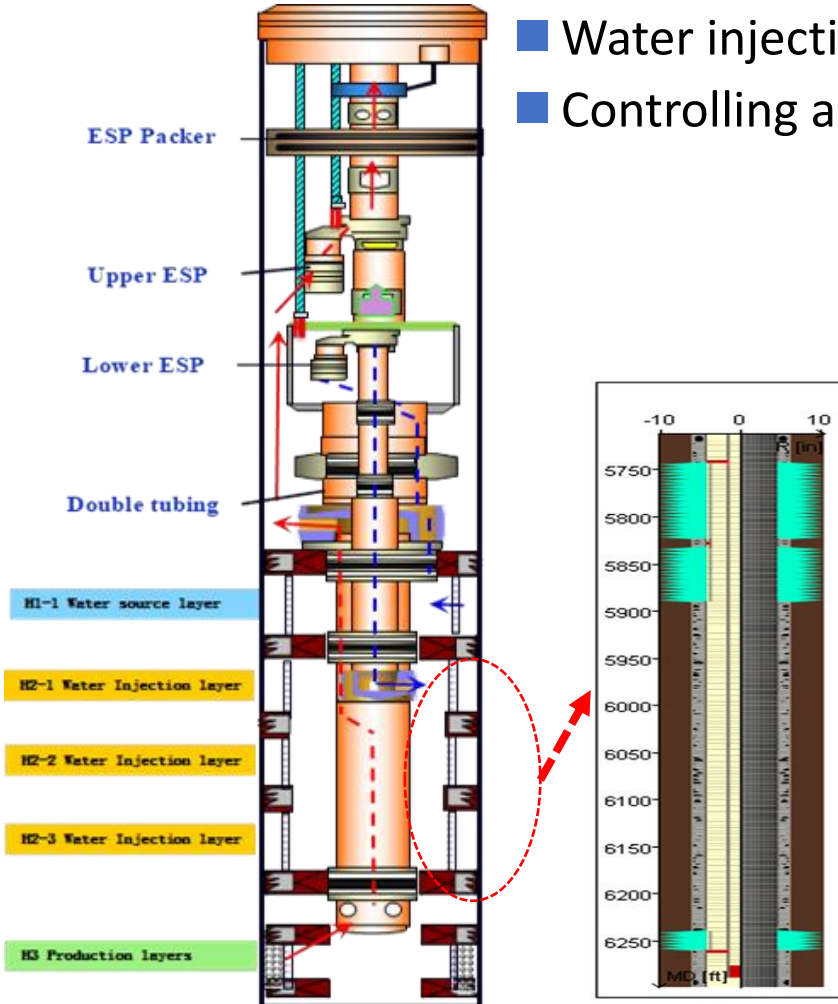
Bottom perf: from 2% to 9%

Case Study 5

OTC-34658-MS

Zone	Base Injectivity	Target Injectivity
H2-1	18%	30%
H2-2	6%	34%
H2-3	76%	36%

- Water injection well in triple operations wells
- Controlling a prescribed outflow by FloFuse



Stable water cut/
increasing oil production by
60%

Increase oil production of
32 Sm³/d

Reduced Water cut/
increased Oil

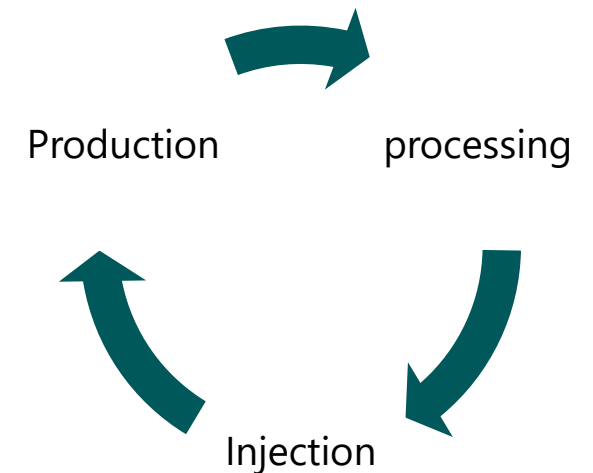


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Summary

- The technology has been applied in various applied in different type of injection wells with various injectants.
- Various surveillance techniques have been applied and demonstrated the successful application of the technology.
- The proportional production along the wellbore has been focused over last 30 years within industry, the same efforts should be applied toward design optimisation of injection wells too.



Thank you

Questions?



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