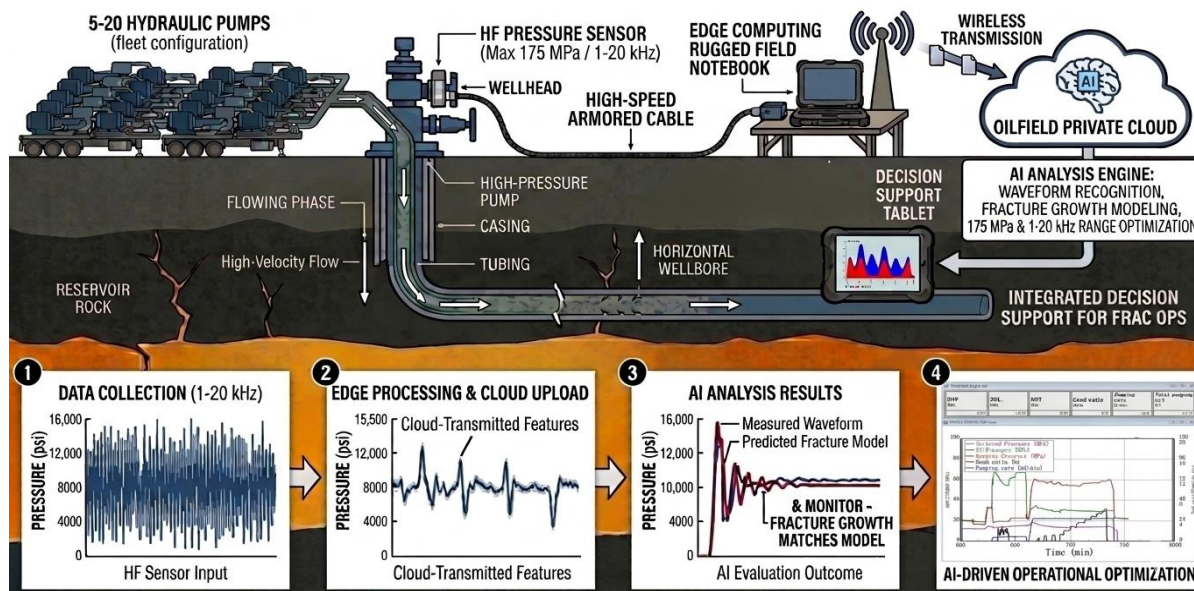


High Frequency Pressure Monitor & Evaluation (HFPME)

Real-Time Hydraulic Fracturing Monitoring & Optimization Technology

What is HFPME?

HFPME measures 1~20 kHz high-frequency pressure data exclusively at the wellhead (no downhole tools required). Using pump-stop water hammer effect and signal decoupling & cepstrum analysis, it monitors perforation cluster initiation and temporary plugging effectiveness in real time, optimizes on-site operations, quantifies formation stimulation parameters per stage, and provides data-driven support for shut-in/flowback, and optimization and multi-well fracture interference monitoring.



Technical Principles & Key Functions

Continuous millisecond-scale pressure fluctuations are generated throughout the entire pumping process, and pump shutdowns produce a distinct natural post-pump-stop water hammer effect. These pressure waves propagate rapidly down the wellbore, interact with perforation cluster fractures, reflect back to the wellhead, and are captured by the HFPME sensor. Reflected signals are processed and interpreted to quantitatively evaluate fracturing stimulation effectiveness.

1. Perforation cluster initiation and temporary plugging effectiveness

2. Fracture geometry scale, complexity, and stimulation effectiveness

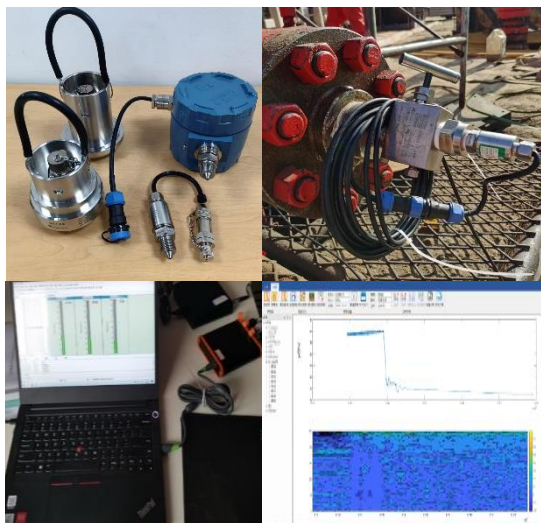
3. Casing deformations or damage in fracturing wellbores

4. Monitoring of fracture interference on multi-well platform

5. Optimize shut-in time, flowback control to improve productivity

On-site Instrument Installation & Applications

Featuring rapid deployment with one-hour installation and commissioning, HFPME has been successfully deployed across over 400 hydraulic fracturing wells and 5,000+ fracturing stages in China and Iraq's Halfaya Oilfield.

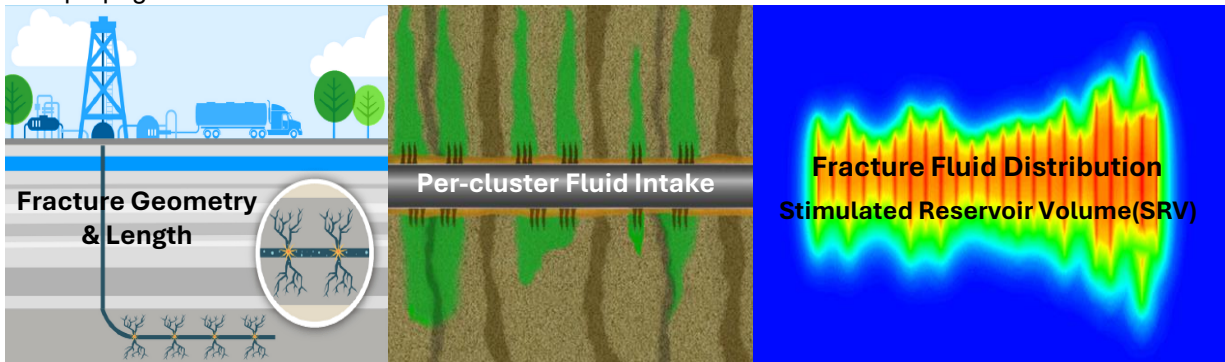


High Frequency Pressure Monitor & Evaluation (HFPME)

Real-Time Hydraulic Fracturing Monitoring & Optimization Technology

Quantifies full fracture parameters, formation permeability & SRV

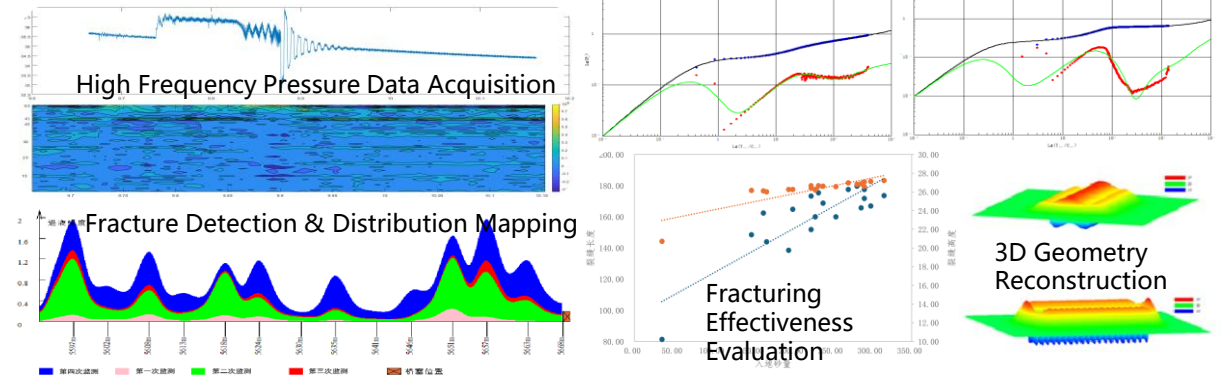
Leveraging the natural post-pump-stop water hammer effect inherent in hydraulic fracturing operations, and combining wellhead high-frequency pressure monitoring with a cloud-based interpretive analysis platform, HFPME enables real-time monitoring of perforation cluster initiation and propagation.



On-Site Decision Support & Actionable Productivity Insights

Real-time Per-cluster fluid intake data guides temporary plugging timing & diverting agent dosage

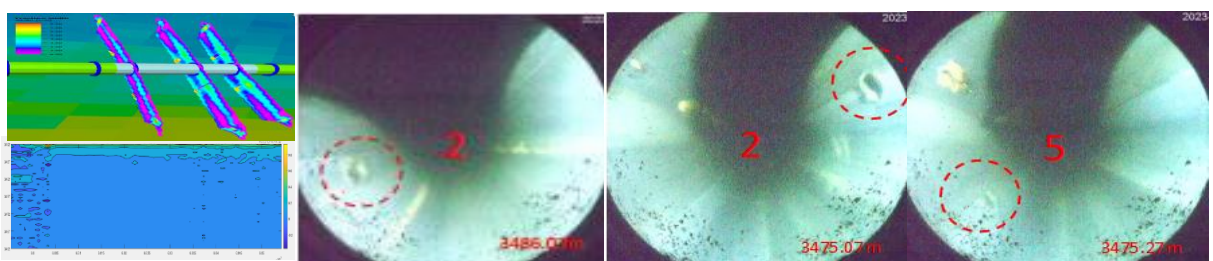
Fracture geometry & SRV enable accurate productivity prediction & formation flow analysis



Perforation Cluster Initiation Detection Accuracy: >90%

HFPME results demonstrate 90% consistency with downhole camera imaging for perforation cluster initiation locations in Daqing Oilfield. The technology achieves a minimum resolvable cluster spacing of less than 5 meters.

HFPME technical case was published in SPE Journal with paper number SPE -228229-MS (2025).



HFPME Results

Downhole Camera