ON-SITE WATER ANALYSIS OF HYDRAULIC FRACTURING WATERS

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Hach Company

HACH COMPANY: A GLOBAL LEADER IN WATER ANALYTICS

- Over 75 years of analytics expertise in water
  - 1933: Dr. Bruno Lange GmbH founded in Berlin
  - 1947: Hach founded in Ames, Iowa
  - 1999: Acquired by Danaher Corporation
    ($13B in Revenue, 2010)

- Leader in laboratory and process monitoring for:
  - Municipal drinking and wastewater
  - Industrial wastewater and utilities

- Commitment to customer value creation
  - Strong investment in R&D and acquired technologies
    - 527 patents covering 130 patent families
  - Highest quality products with reliable delivery
  - Leadership in customer service, technical support, and training

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IMPORTANCE OF WATER TESTING

Type	Key Questions	Role of Water Quality Data
Influent (source)	• It costs $400K to $700K to transport water to site, how do I validate the product to avoid costly issues?	• Provide selection/acceptance criteria of purchased water prior to a frac job • Maximize compatibility with fracturing additives and avoid interferences
Reuse (flowback)	• How do I determine if the water is acceptable for reuse? • What is the best method for treating the water? • How do I avoid over/under treating?	• Optimize blending and onsite treatment • Avoid interferences with friction reducers –TDS (Chloride) • Prevent down hole plugging – TSS, Bacteria • Minimize formation of precipitates – Barium, Iron, Hardness, Silica, Strontium, Sulfates • Protect capital equipment from corrosion – Bacteria, Dissolved Oxygen
Disposal (flowback/ produced)	• How much will it cost to treat the water? • What are my disposal options?	• Data for reuse vs. disposal decisions • Comply with regulations

Water quality information is key to avoiding costly issues and achieving long term well performance

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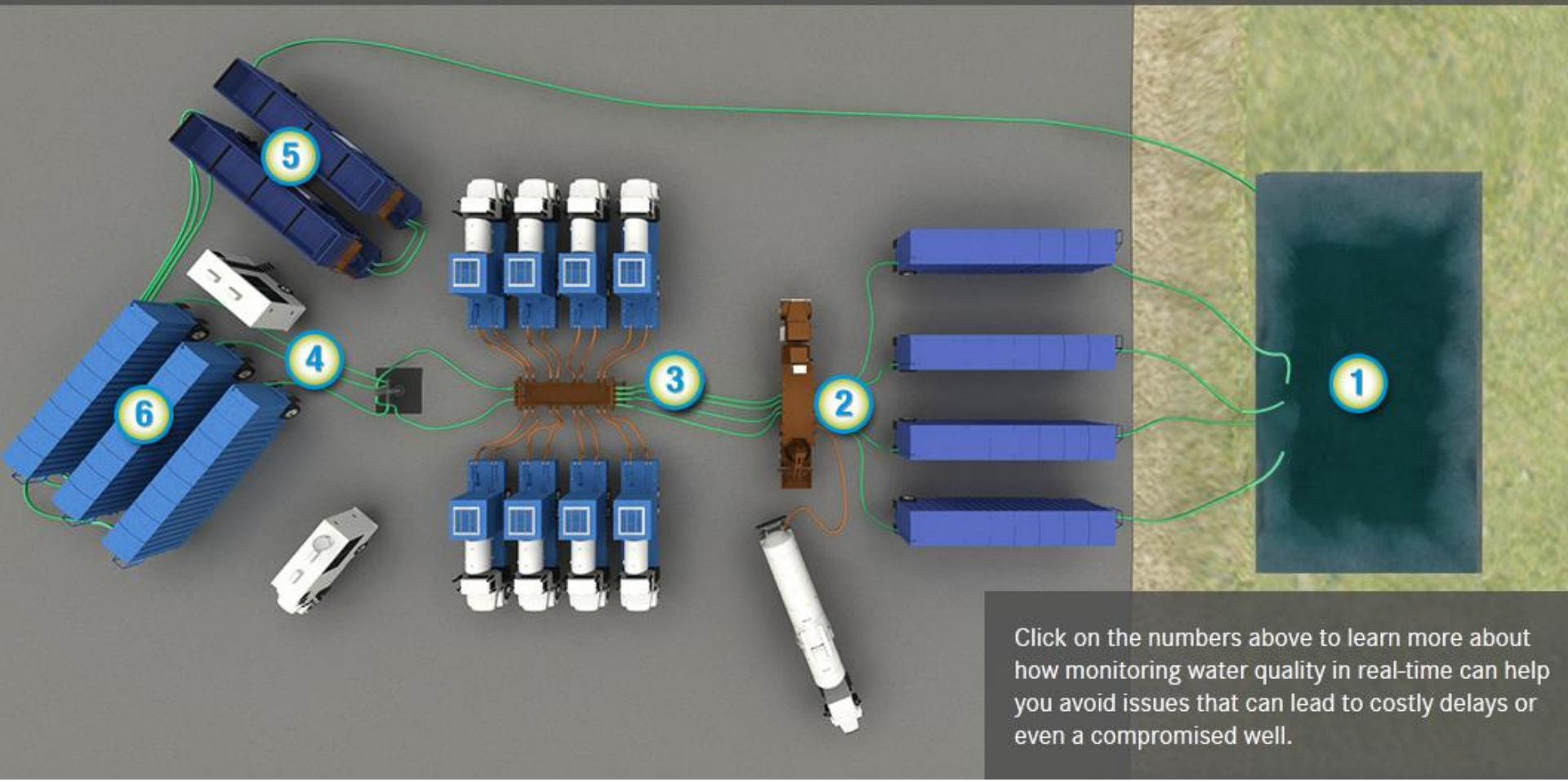
Hydraulic Fracturing Water Analysis



Measuring regularly at different points in the process can result in significant cost savings and early identification of potential problems.

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HYDRAULIC FRACTURING WATER ANALYSIS KIT

- Includes instruments, reagents, and methods to support parameters critical to hydraulic fracturing applications:
  - Alkalinity
  - Bacteria: Sulfate-reducing (SRB), Iron-related (IRB), Slime-forming (SLYM)
  - Barium
  - Chloride
  - Conductivity
  - Hardness
  - Iron
  - pH
  - Sulfate

- Provides real-time, on-site results
  No need to spend the time and money to send samples to a regional lab!
- Supports analysis of:
  - Source water
  - Produced water
  - Frac fluid
  - Flowback water
  - Water treatment
  - Drilling fluids
  - Enhanced oil recovery

- *Additional parameters may be added as needed*

The newly developed methods can provide real-time field results for key hydraulic fracturing waters via a portable kit

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OTHER KEY LAB & FIELD PRODUCTS

Instruments

- 2100Q Portable Turbidimeter

- DR 2800 Portable Spectrophotometer

- DR 3900 Benchtop Spectrophotometer

- TSS Portable Probe

- MP-6 Meter

HQd IntelliCAL™ Probes

- Chloride ISE
- Dissolved Oxygen
- ORP

Chemistries

- Boron
- Bromine
- Silica
- Chlorine / Chlorine Dioxide
- Manganese
- Phosphate
- Ferrous Iron
- BARTS (Heterotrophic Bacteria)

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CONTINUOUS MONITORING

Robust Online Analyzers

- Mount directly into the treatment process for continuous analysis of:
  - Chlorine
  - Conductivity
  - Dissolved Oxygen
  - Oil in water
  - pH
  - Suspended Solids
  - Total Organic Carbon
  - Turbidity
  - UV transmittance
  - And many more

Monitor continuously and adjust processes in real-time to optimize treatment effectiveness and reduce costs

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