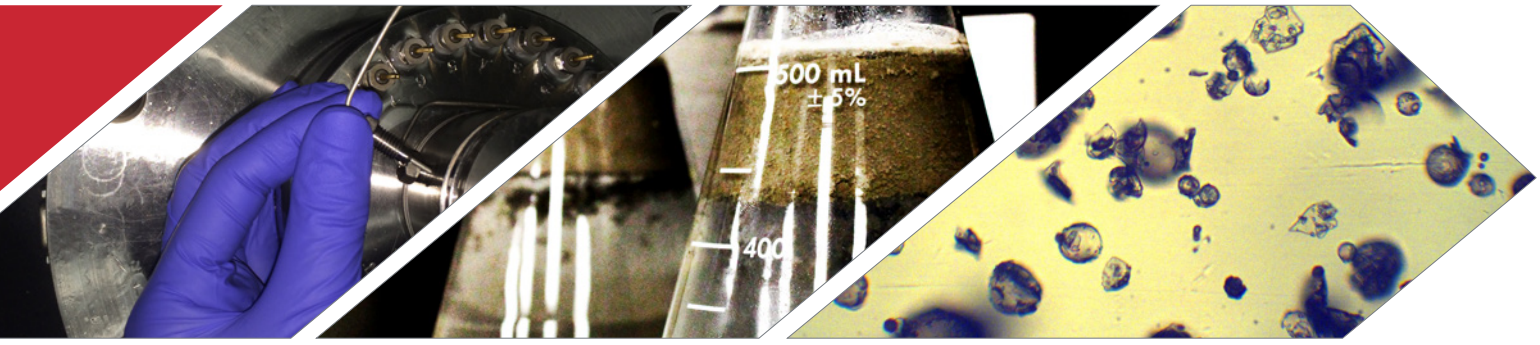
Analytical Testing and Analysis

Support for Drilling and Completions Fluids Technology



CSI Technologies provides analytical testing services for chemical characterization to support drilling and completions operations. In addition, contract QC for additives and chemicals is available to ensure that chemical performance meets required product specifications.

Water Quality Testing for Cementing Mix Water

Pre-job cement testing should be conducted with actual rigsite water to prevent unintended cement performance variations on location. Compounds in water, such as chlorides, sulfates and calcium, can affect cement slurry properties such as thickening time and compressive strength. These compounds can occur naturally in water or as a result of contamination.

Water quality testing at CSI Technologies includes:

- Chlorides
- Sulfates
- pH
- Calcium (hardness)
- Nitrates
- Total dissolved solids

Fourier Transform Infrared Spectroscopy (FT-IR)

FT-IR is a powerful tool of chemical characterization. In the infrared region of the spectrum, the position, intensity, and shape of absorption peaks are collected to identify characteristic functional groups and determine the composition of organic, inorganic, and polymer samples. With the assistance of attenuated total reflectance (ATR) technology, a broad range of materials, including powder, liquids, and resin polymers, can be examined without further sample preparation.

FT-IR at CSI Technologies will be used to serve the following purposes:

- Additive characterization
- Compound identification

Ultraviolet-Visible Spectroscopy (UV-Vis)

UV-Vis is another powerful tool of chemical characterization based on the absorption spectrum. It measures the absorption of liquid samples or dry blends extracts in the ultraviolet-visible region. A variety of organic compounds demonstrates characteristic absorptions in this spectrum region.

UV-Vis at CSI Technologies will be used to serve the following purposes:

> QA/QC of liquids and dry blends
> Additive characterization

Particle Size Analysis

Particle size analysis is one of the most important physical characterizations of powder materials. It is often conducted as a quality-assurance procedure of dry powders, slurries, and additives. The method is based on a combination of air flow resistance and light scattering principles. A typical sample size of 10 grams or more is required.

Particle size analysis at CSI Technologies will provide the following information:

> Particle size distribution curve
> Surface weighted mean diameter
> Volume weighted mean diameter
> Specific surface area
> Uniformity

Optical Microscopy

Optical microscopy allows us to directly observe the dry blend or the surface of set cement samples. It is a qualitative analysis to confirm the presence of certain additives, especially with the help of a polarizer that can distinguish crystal and non-crystal solids.

Optical microscopy at CSI Technologies will be used to serve the following purposes:

> Morphology characterization
> Additives presence confirmation

Surface Contact Angle and Surface Tension Tests

Surface contact angle and surface tension tests are routinely conducted with a goniometer to measure the surface wettability. Wettability is a measurement to determine if the spacer effectively cleaned the wellbore in cementing operations. In order to properly bond with cement, the surface of casing is desired to be well water wetted and completely free of mud residue. As a complementary to reverse-emulsion tests, surface contact angle and surface tension will greatly facilitate the surfactant selection and spacer design. In stimulation and hydraulic fracturing operations, the interaction between stimulation/fracturing fluids and formation rocks also has a significant impact over oil recovery. The surface contact angle and surface tension studies will help us evaluate the emulsions and improve the performance of stimulation/fracturing fluids.

Surface contact angle and surface tension tests at CSI Technologies will assist with the following:

> Spacer design
> Surfactant selection
> Water wettability determination
> Emulsion studies for stimulation and hydraulic fracturing fluids

Pycnometer Analysis

Pycnometer analysis gives volume and density information of powdered samples. It is based on a gas displacement method, using helium to measure the volume inaccessible to gas, then calculating density from the volume weight ratio.

Pycnometer tests at CSI Technologies will provide the following information:

> Volume
> Density