Automated Vision Based Particle Analysis
Particle Size Analysis of Drilling Fluids

• Introduction
  • Drilling muds or fluids are complex aqueous or oil-based suspensions designed to fulfill a number of important functions during the oil extraction process.
  • Main Functions
    • Provide hydrostatic pressure to prevent formation fluids from entering the well bore
    • Keep the drill bit cool and clean during drilling
    • Carry out drill cuttings
    • Suspending drill cuttings while drilling is paused and while drilling assembly is brought in and out of the hole
    • Avoid formation damage and limit corrosion
Importance of Particle Size for Mud

• Mud performance controlled by manipulating the mud composition and the properties of the constituents through the addition of different additives.

• Particle size significantly affects the way in which the mud interacts with the surrounding geology.

• Particle size and shape measurements play an important role in the formulation of high performance drilling muds.

• Particles smaller than the pore size of the surrounding geological formation will bridge rock pores during mud circulation, leading to the formation of a filter cake that prevents the egress of fluids from the well during drilling.

• This “filter cake” protects the surrounding rock from damage while simultaneously preventing fluid loss and achieving well stabilization.
Drilling Mud Functions Include;

**Seal Permeable Formations** – Materials (including LCM’s - Lost Circulation Materials) are added to the mud to bridge large openings / fractures in the bore wall, and form a thin low permeability filter cake on the bore wall – particle size measurement of the added material is critical to ensure effectiveness of bridging particles
Drilling Mud Functions Include;

**Control** | **Formation** | **Hydrostatic Pressure** – Unbalanced formation pressures can cause unexpected influx of pressure in the well, possibly leading to a blowout. Mud density is controlled (often with barite or other weighting materials) to balance pressure & keep the wellbore stable. – particle size measurement of the barite & fines within the drilling mud is critical to controlling the density of the drilling mud in order to balance with the formation pressure pressure.
Typical Instruments Currently Used

• Sieves
• Laser
• Vision

• Only Vision can do shape analysis.
Sieves

• Sieve Analysis

• Used for many years, simple & inexpensive
• Disadvantages:
  – Time (Sedimentation and Sieving are both slow and time consuming processes)
  – Particle Size (Particles too small for separation by sieving to be practical)
  – Error (Over-energetic sieving causes attrition of the particles and thus changes the calculated particle size distribution)
Laser Diffraction

- Quickness and ease of use
- Disadvantages:
  - Water droplets (in oil based) Oil droplets (in water based) mud measured as particles.
  - Non-spherical objects (large discrepancy between laser measurements)
  - Laser 1D (equivalent sphere) and not recommended for large aspect ratio.
  - Distortion of Measurements (existence of “ghost” particles caused by sharp edges on the objects which produce high angle diffraction
  - Acicular particles (shows much larger sizes compared to laser diffraction, undercounts events generated by major chord
  - Laser diffraction intrinsically biased towards the smaller edge of spectrum.
  - Difficulty with coarse materials
Lasers and Large Particles

As particle size increases agreement between laser measurements is lost. A reproducibility test recently performed found the following data with three different Laser instruments:

<table>
<thead>
<tr>
<th>Instrument</th>
<th>D10</th>
<th>D50</th>
<th>D90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument 1</td>
<td>720</td>
<td>1602</td>
<td>2866</td>
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<tr>
<td>Instrument 2</td>
<td>834</td>
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<td>2531</td>
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<tr>
<td>Instrument 3</td>
<td>810</td>
<td>1466</td>
<td>2949</td>
</tr>
</tbody>
</table>
Imaging Advantages

- Real time 2Dimensional particle shape analysis.
- The particles are oriented in the fluid dynamically designed flow cell to measure the largest length and widest section of the particles. All aspect ratios are measured correctly
- Direct measure of particle area – a two dimensional measurement.
- Direct measurement of particle perimeter – a two dimensional measurement.
- Direct measure of major axis and minor axis – a two dimensional measurement.
- Able to separately measure various particles separately water, barite, polymer using size shape and color data
- Direct measurement of particle color.
- Large particle range – 2” down to .7 micron
At Line Dilution
Cross Cut Sampling
Typical Vision Repeatability
- Fused one piece construction with no recesses or steps where product can adhere to and build up
- Pressures to 600 BAR
- Integral Jet Spray Ring
- Adjustable Gap Size dependent on sample present
Solid Particles and Water Detected Simultaneously (OBM)
Simultaneous Solid and Droplet Size Distribution

![Solid and Water Size Distribution Chart](chart.png)
Typical Vision Interface
Image of Mud Particles
Thank You

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