

Size Degradation of Lost Circulation Materials (LCMs)

Sharath Savari

Global Technical Advisor

HALLIBURTON

Baroid

November 21, 2013

Conventional LCMs—First Line of Defense



Walnut shells



Ground marble



Graphitic carbon



Fibres

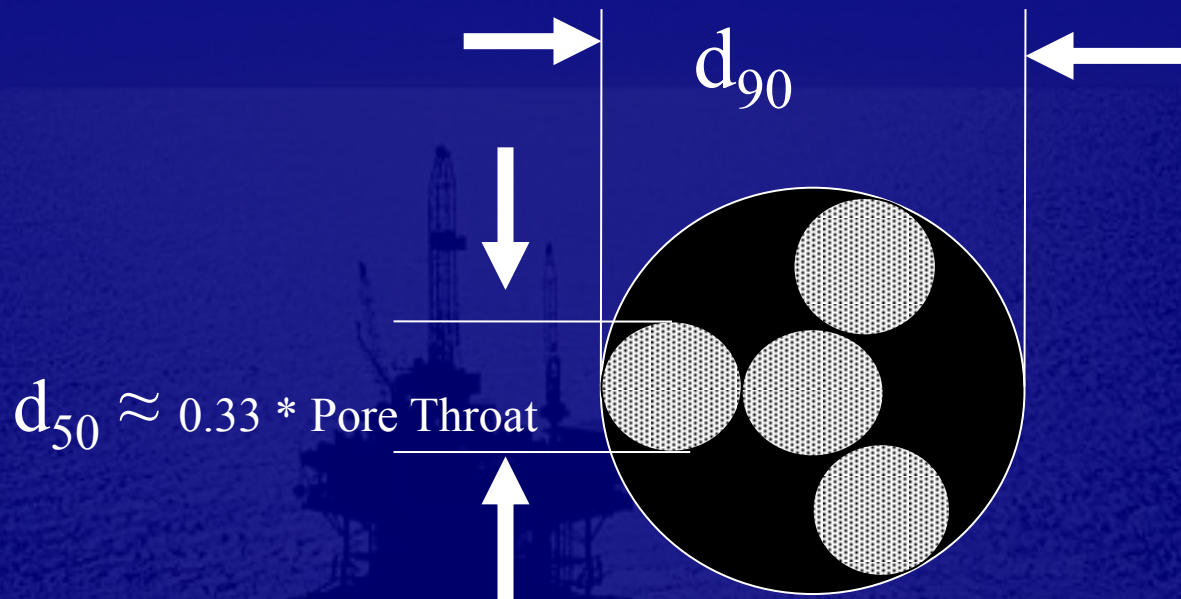
Selection Criteria for Particulate LCMs

- Particle Size Distribution (PSD)
- Concentration

Abrams' Median Particle-
Size Rule (1977)

Selection Criteria for Particulate LCMs

Abrams' Median Particle-
Size Rule (1977)



Particulate LCMs

- Size degradation with time – Very well known
- Critical to maintain PSD
 - Minimize Volumes (in turn Costs)
 - Maintain Effective Concentration
 - Effective Treatment

Size Degradation - Where

- Drilling Fluid with LCMs flowing through Bits, Pumps
- Flowing through Annular spaces



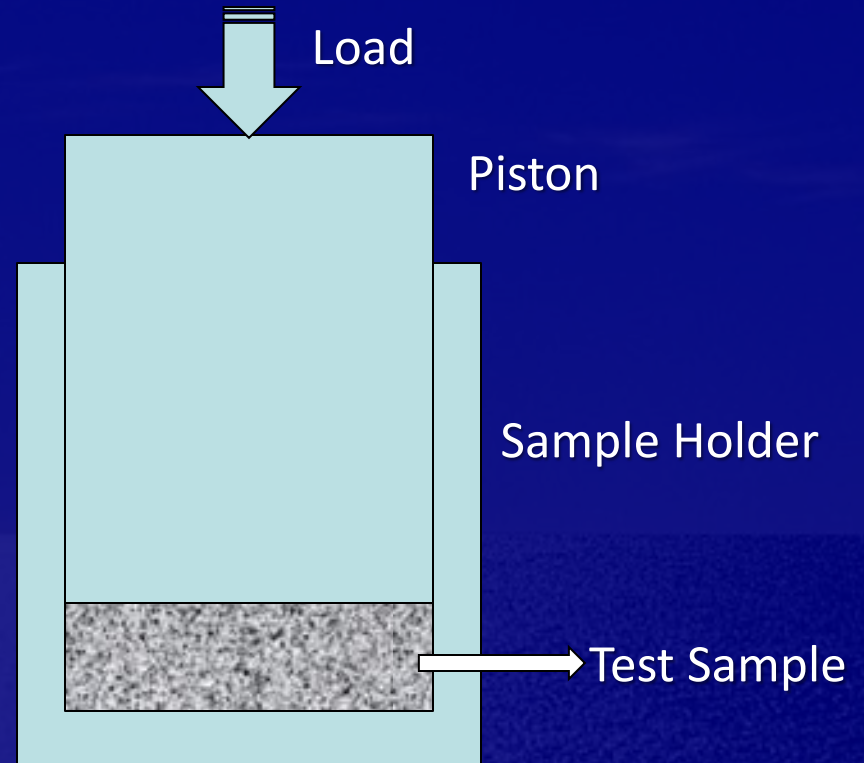
Size Degradation - Studies

A. Mechanical Attrition tests (Crush Tests)

B. Shear Degradation tests

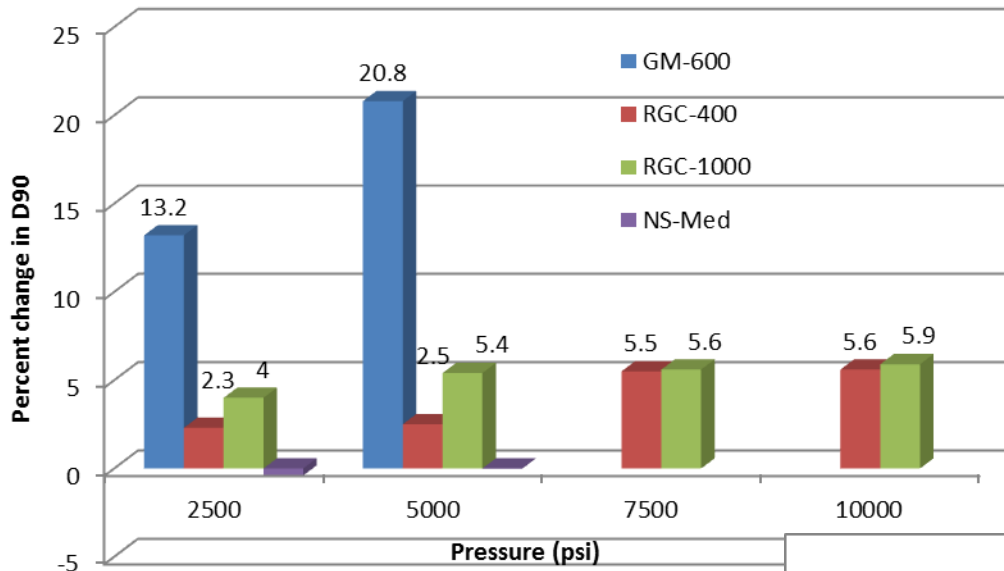


Size Degradation – Crush Tests



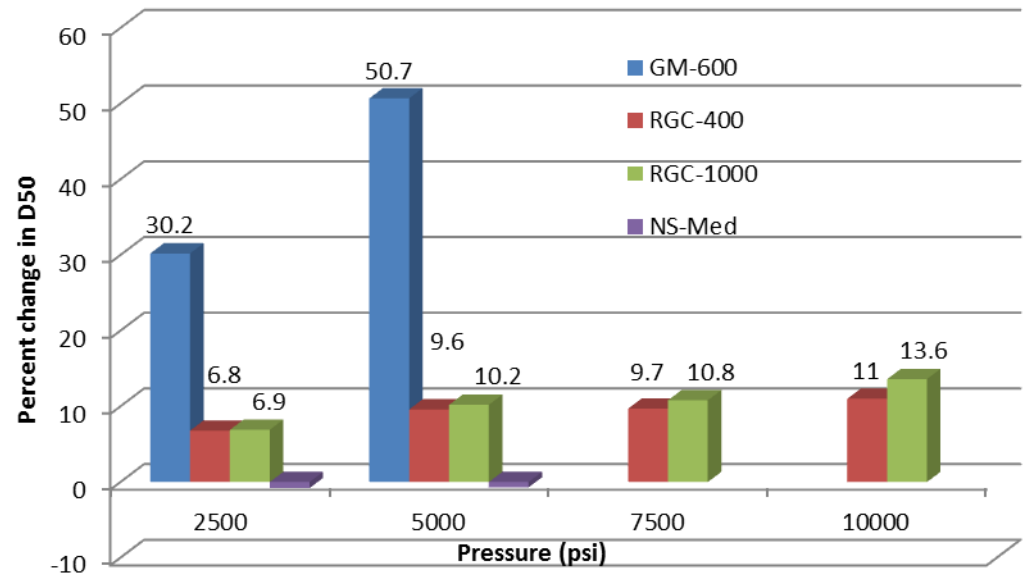
- Same volume of test samples
- Subjected to 2500, 5000, 7500 and 10,000 psi

Size Degradation – Crush Tests Results

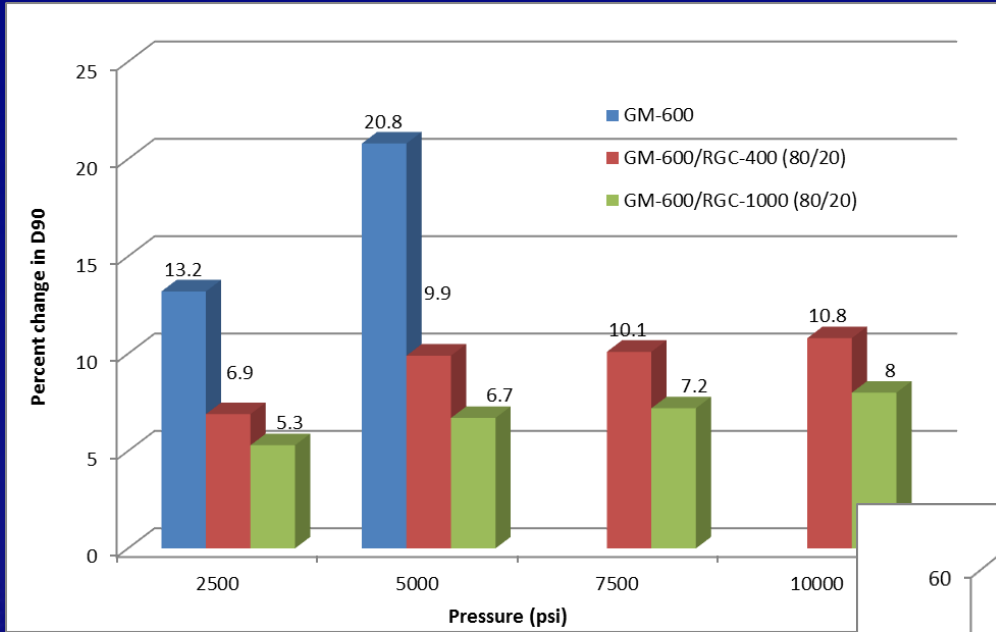


Individual Materials

**Resilient Graphitic
carbon and Nut shells
- Performed best**

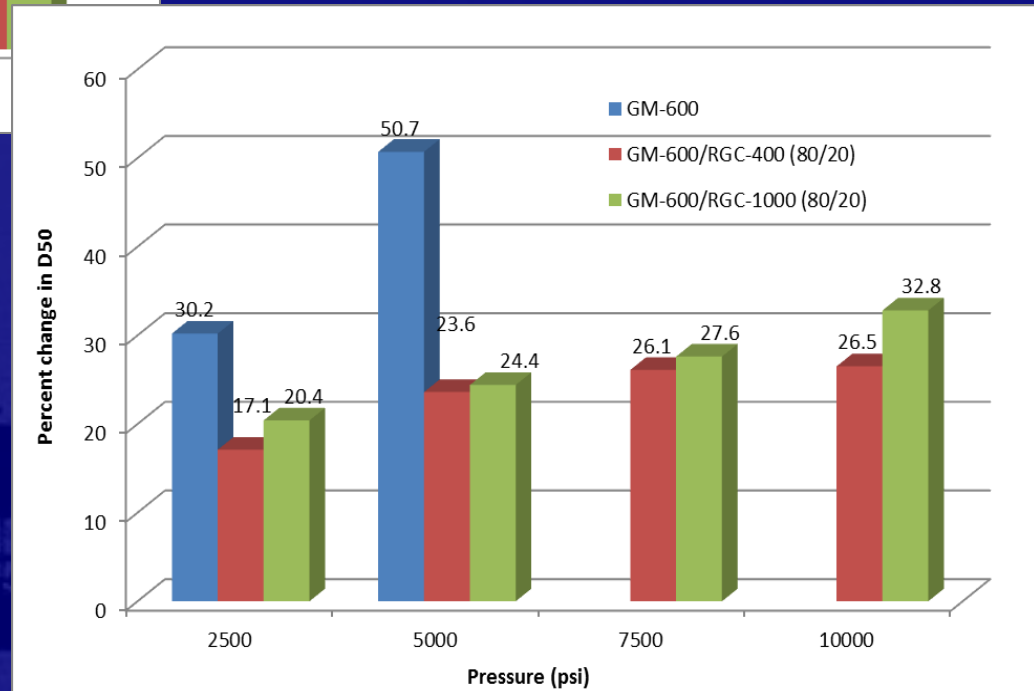


Size Degradation – Crush Tests Results



**Combinations:
 Effect of 20% by Vol
 of RGC**

**Addition of Resilient
 Graphitic Carbon
 Increased Resistance
 – 50% less change**



Kumar, A. et al, Wellbore Strengthening-The Less Studied Properties of Lost Circulation Materials, SPE 133484. SPE ATCE 2010

Shear Degradation

- Test LCMs added to Drilling fluids
- Subjected to shear (Hamilton or Silverson)
- Measure PSD before and after shear (w.r.t time)
- Determine Shear Resistance

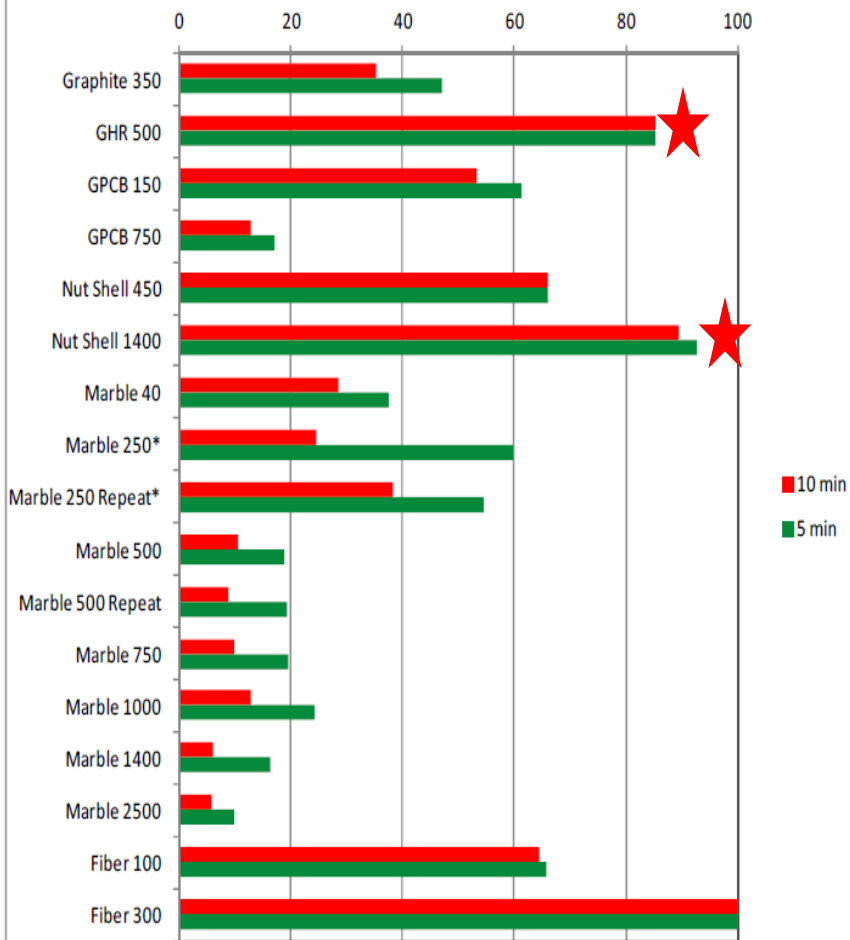
Shear Degradation - 1

| 7000 rpm Shear | Hamilton Beach 5 min | Hamilton Beach 10 min | Hamilton Beach 15 min | Silverson 5 min | Silverson 10 min | Silverson 15 min |
|--|----------------------|-----------------------|-----------------------|-----------------|------------------|------------------|
| Black Walnut Hulls Shear Degradation % | 1.5 | 2.0 | 2.0 | 9.0 | 9.3 | 9.9 |
| English Walnut Hulls Shear Degradation % | 3.3 | 3.3 | 4.3 | 7.7 | 9.5 | 9.9 |
| Pecan Hulls Shear Degradation % | 11.7 | 14.3 | 15.0 | 24.2 | 26.9 | 28.3 |
| Resilient Graphitic Material Shear Degradation % | 0.5 | 0.5 | 1.5 | 7.6 | 15.9 | 16.9 |
| Ground marble Shear Degradation % | 5.2 | 9.6 | 12.1 | 99.5 | 99.5 | 99.5 |

| 7000 rpm Shear | Hamilton Beach 5 min | Hamilton Beach 10 min | Hamilton Beach 15 min | Silverson 5 min | Silverson 10 min | Silverson 15 min |
|--|----------------------|-----------------------|-----------------------|-----------------|------------------|------------------|
| Coarse Barite Shear Degradation % | 2.2 | - | 6.8 | 43.0 | - | 80.5 |
| Black Walnut Hulls Shear Degradation % | 10.0 | - | 6.4 | 4.0 | - | 12.4 |
| Resilient Graphitic Material Shear Degradation % | 6.2 | - | 9.6 | 3.8 | - | 12.0 |
| Ground marble Shear Degradation % | 3.9 | - | 3.8 | 20.7 | - | 42.1 |

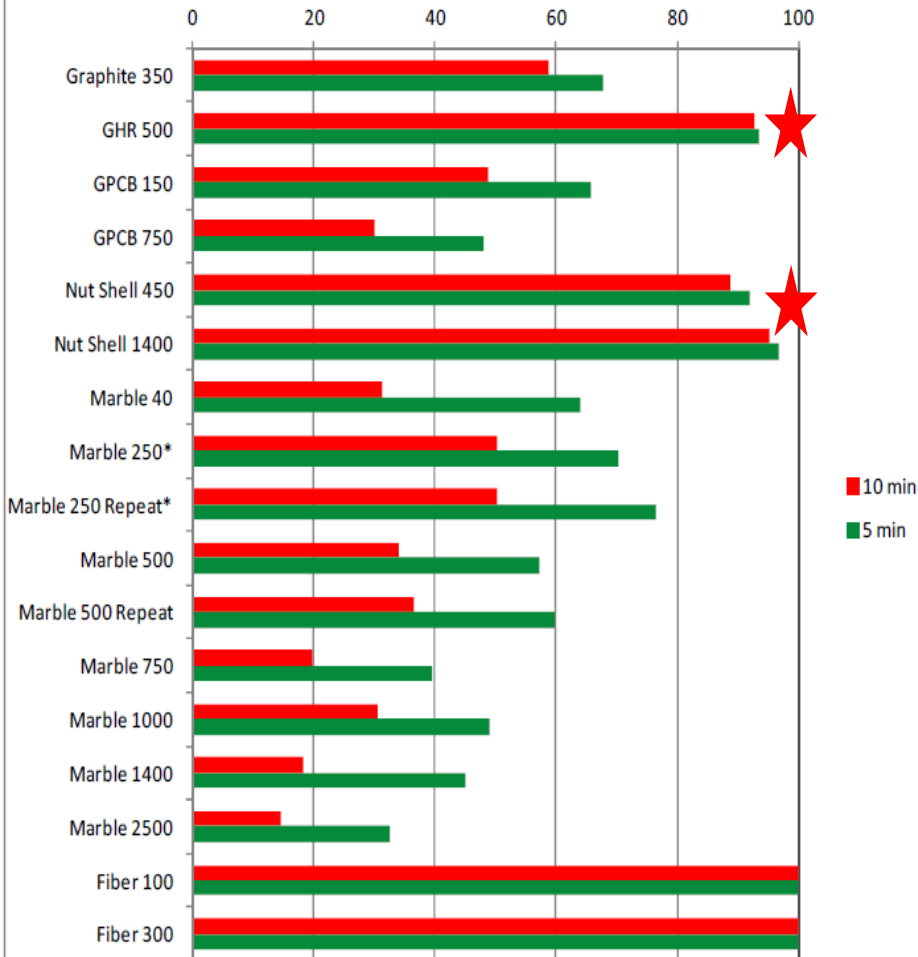
Shear Degradation - 2

Relative Resistance to Shear Degradation: d_{50}



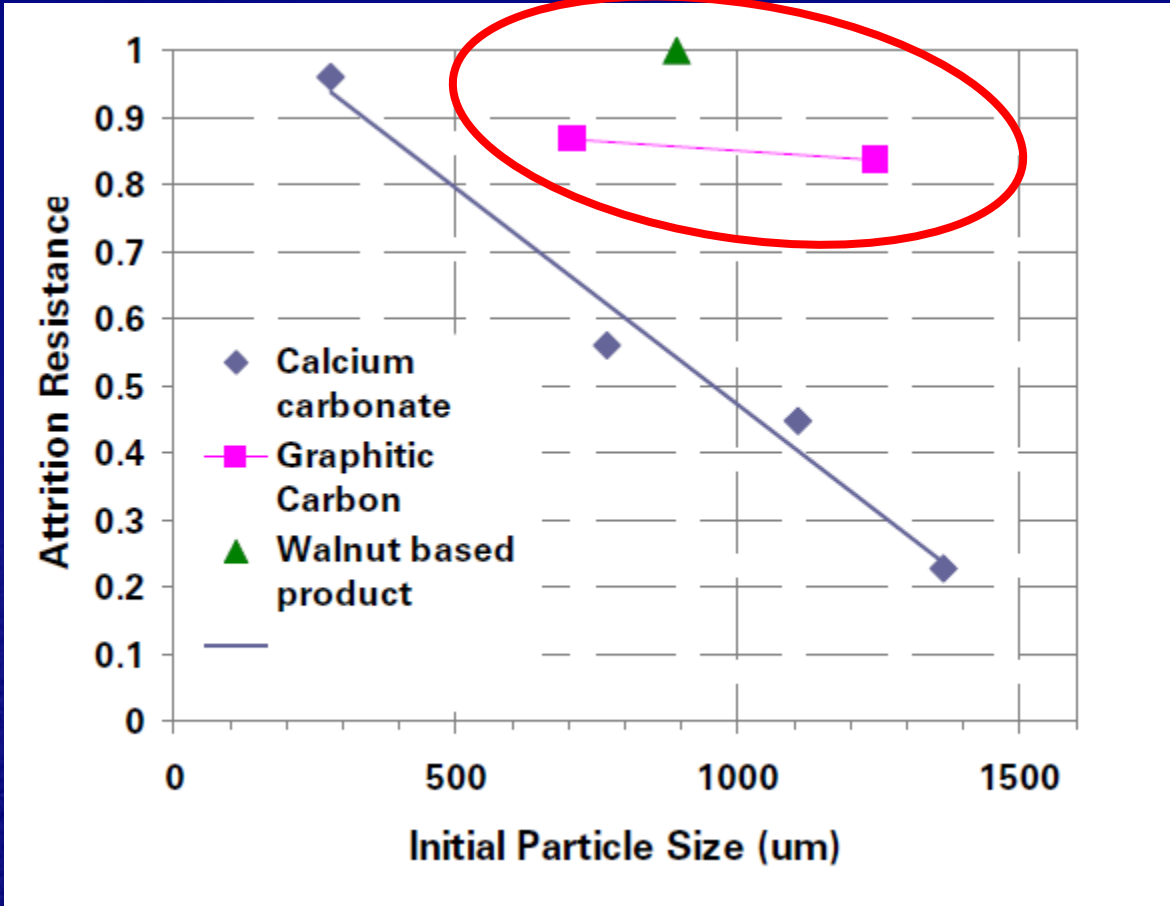
* Marble 250 and 250 Repeat were obtained from different suppliers

Relative Resistance to Shear Degradation: d_{90}



* Marble 250 and 250 Repeat were obtained from different suppliers

Shear Degradation - 3



- Shear rate and Fluid viscosity effects
- But, particle type and initial size are most important factors

Ground Marble highly prone to attrition , compared to Graphitic carbon or nut shells

Size Degradation of LCMs - Summary

- Different materials behaved differently
- Ground Marble based materials prone to highest size degradation
- Graphitic carbon and Nut shell based materials are better

What do you think?

Thank You & Questions



Sharath Savari
Global Technical Advisor



Sharath.Savari@Halliburton.Com



Office: +1-281-871-3021
Cell: +1-713-677-1489



www.halliburton.com