Riteks RadiLock Fiber Technology

RadiLock Fibers

- Next generation fiber technology based on Polyacrylonitrile (PAN) acrylic obtained from the reaction of acrylonitrile monomers.
  - Precursor to Carbon fiber.

- Proven to significantly increase the mechanical properties through ionic & chemical bonding with cement and to effectively seal formation fractures improving top of cement, lost circulation control, and fluid loss.

Fiber Characteristics

- Material - PAN Acrylic Fiber
- Fiber Length - 1.8mm, 3mm and 6 mm
  - Milled (0.5-1.5mm) also available in higher denier.
- Acid & Alkali Resistance – Excellent
- Specific Gravity - 1.17 g/m3
- Decomposition Temperature – 330^{o}C/626^{o}F
- Diameter <11 microns (1.0 denier)
  - Very Large Surface Area to Volume Ratio
- Tenacity >600 MPa
- Fiber Color - Natural

RadiLock Fiber Count

Product	Cut Length mm	Den	Dtex	Fiber Count Kg.	Fiber Count lb.	Specific Gravity	Diameter µ
RadiLock 1.8mm	1.8	1.00	1.11	4,500,000,000	2,041,186,610	1.17	11.00
RadiLock 3mm	3.0	1.00	1.11	3,000,000,000	1,360,791,073	1.17	11.00
RadiLock 6mm	6.0	1.00	1.11	1,500,000,000	680,395,537	1.17	11.00
RadiLift 6mm	6.0	1.50	1.67	1,000,000,000	453,597,024	1.17	13.47

RadiLock Fibers Benefits

- Used in areas where lost circulation control is critical, while also providing a more durable, long-lasting cement.
- The only multifunctional fiber technology in the market today:
  - Return to surface properties are enhanced
  - Pumping with cement due to multiple the benefits including the benefit of mechanical properties, fluid loss, improved bonding
- Fiber technology that can be dosed in the bulk plant for consistent loadings, while also being hand dosed at site in cement & spacers.

Why Should Acrylic Fibers be run?

- Lost Circulation Control
- Improved return to surface preventing Top Side / Secondary Cementing
  - Potential for less excess cement/additives
  - Working in areas that nothing has worked
  - Enhances current LCM's used in cement at 1/8# per sack
- Stabilizes cement to produce a more durable, better bonded cement sheath & maximizing casing support
- Improvements to bond logs

Additional Benefits of RadiLock Fibers

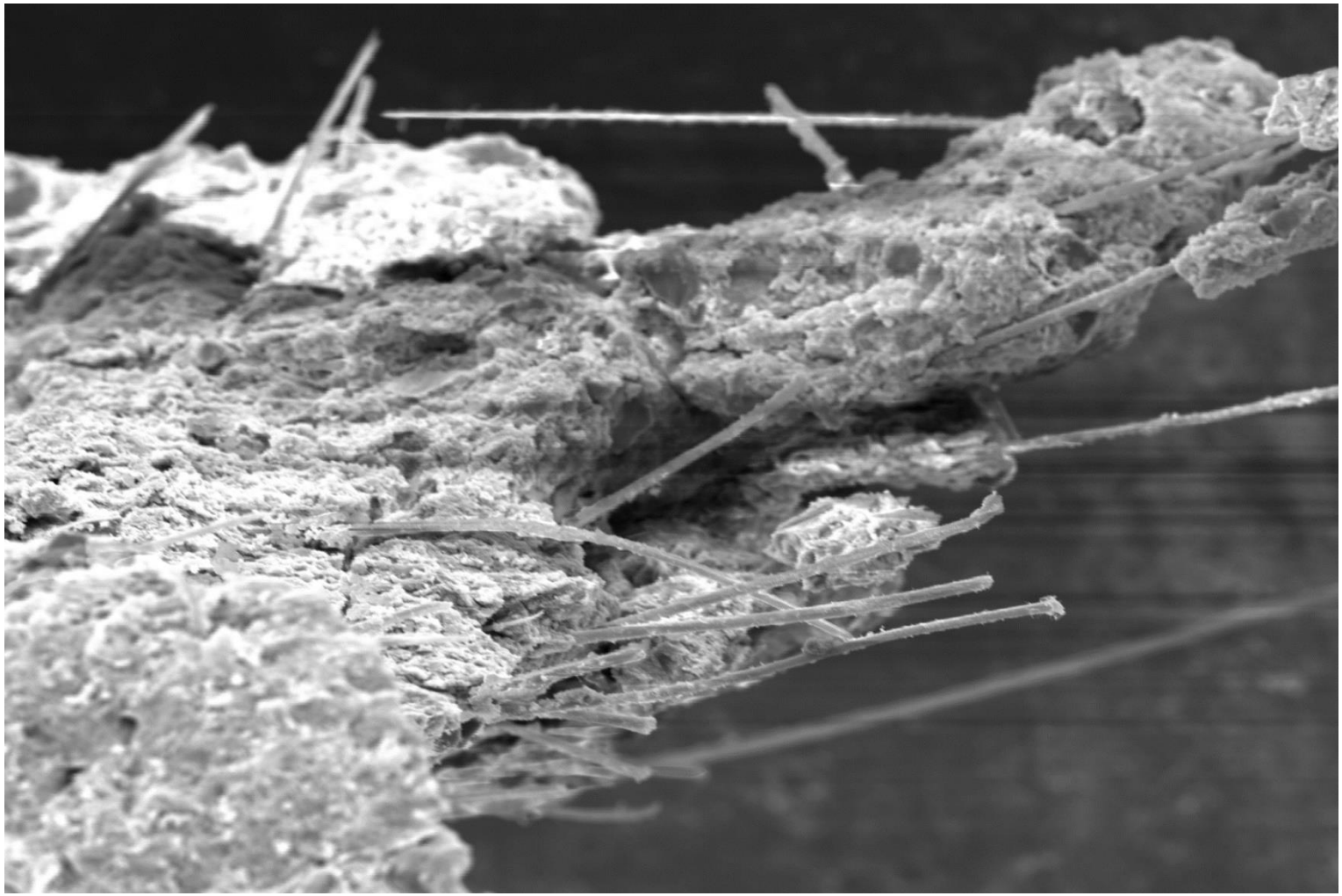
- Improvements in the life of the well for greater zonal isolation, protection from corrosion, contaminates, shrinkage, and drilling shock
- Stabilization of foam to support/carry cement for placement, while strengthening foam from encapsulation.
- Elimination of the micro-crack formation which cause permanent weakening
- No negative effects on cement permeability
- Prevent pressure loss / fall back on the back side

Recommended Loading Levels

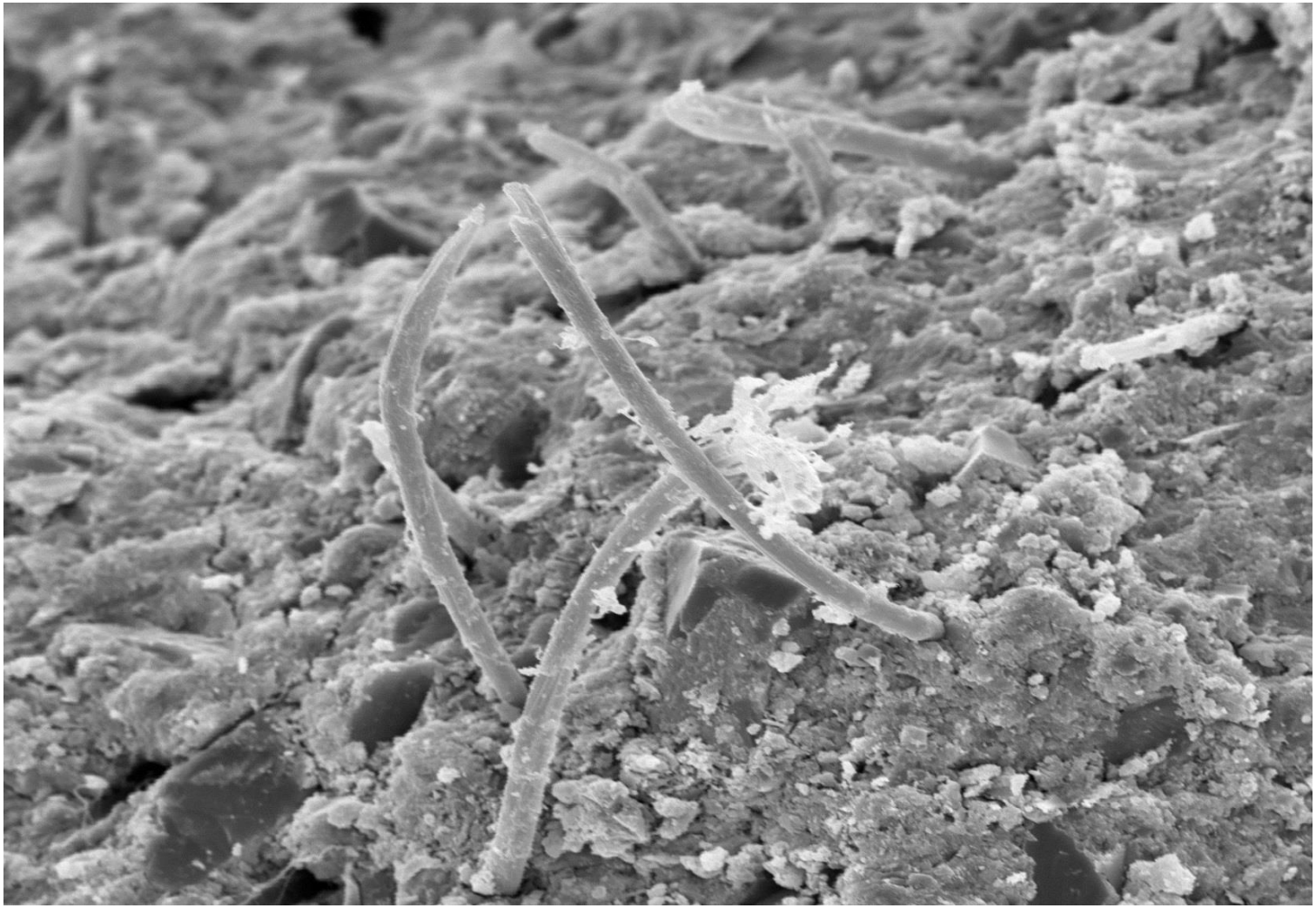
- Spacer loadings
- 0.5-1.0# ppb
  - The spacer can be loaded as high as 2.0#/barrel
  - Very effective in combination with Riteks MS Spacer.

- Cement loadings:
- 0.25% (1/4# per sack) for lead slurries for lost circulation control
- 0.25% (1/4# per sack) for production strings to improve cement durability
- 0.125% (1/8# per sack) for tail slurries surface)

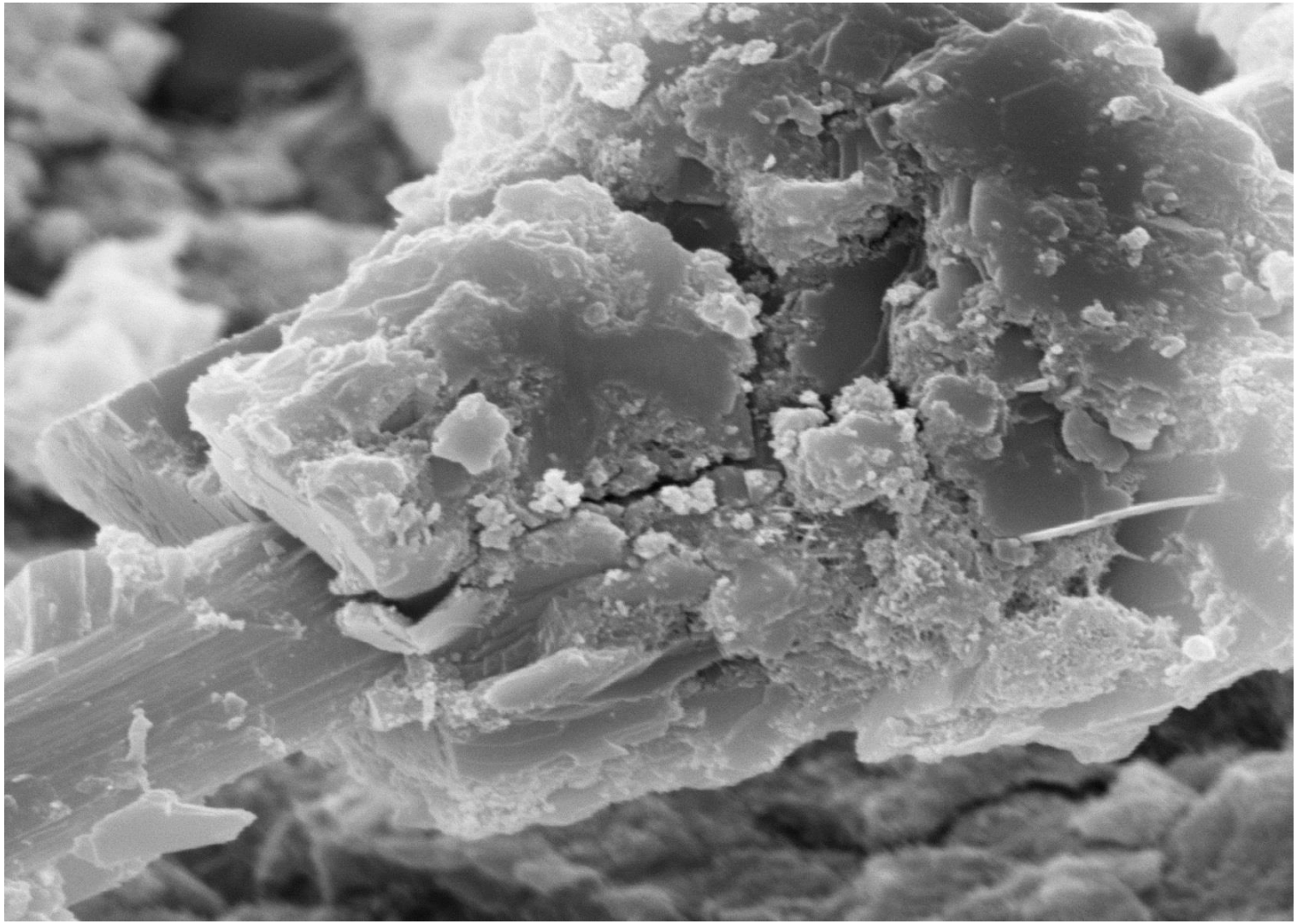
SEM - Images



SEM Images



SEM Images



LCM Application and Benefits

Lost Circulation Additive Properties

Recommended Dosing Level: 0.125-0.25 pounds per sack of cement

Benefits:

- Proven to be very viable for returning circulation in porous formations, by bridging gaps as well as aiding in support/suspension of the slurry design
- Has shown good improvements to bond logs
- Aids in preventing shrinkage of the cement.
- Fluid Loss Control Properties
- Improved filter cake stability and consistent slurry fluidity.
- Improved return to surface
- Potential for less excess cement/additives
- Filter cake stability
- Prevent pressure loss on the back side

Slot Testing – Fiber Blends

- Slurry run with 3#/sk of KolSil & 1/8# per sack of Celloflake in combination with RadiLock 1.8mm, 3mm, & 6mm Fibers.

	Spurt Volume	Spurt Time	Total Volume	Total Time	Test Result
1.8mm Fiber	160 mL	30 seconds	165 mL	30 minutes	PASS
3mm Fiber	20 mL	< 10 seconds	20 mL	30 minutes	PASS
6mm Fiber	50 mL	< 10 seconds	50 mL	30 minutes	PASS

LCM Testing Results

All three slurries passed.

- 1.8mm allowed the most slurry to pass through the slot (approximately one third of the cell volume) prior to sealing it.
- 3mm Fiber allowed minimal slurry to pass through the slot before creating a seal.
- 6mm Fiber also sealed the slot with some slurry to pass though.

Slot Testing Details

- Slot Testing was run at 1mm, 3mm, & 5mm.
- 11.8 ppg slurry run at 1,000psi for 30 minutes
  - 0.25#/sk RadiLock 3mm fibers
  - 0.125#/sk RadiLock 3mm fibers
  - Combo of Phenoseal/Celloflake (0.50#/sk each).

- 1mm Slot Test
  - All 3 products passed the test.

- 3mm Slot Test
  - 0.125#/sk Fiber did not hold the 3mm slot
  - 0.25#/sk Fiber held for 30 minutes
  - PhenoSeal/Celloflake combo held for 10 minutes

- 5mm slot test
  - None of the products passed this test keeping the loadings the same.

Suspension Properties

Pressurized LCM Evaluation

Class H Cement

- RadiTeck Loading: None
- Test Duration: 7 seconds
- Results: All Cement easily passed through porous gravel pack and into container below

Class H Cement

- RadiTeck Loading: 0.25 pounds per sack of cement
- Test Duration: 25 second
- Results: Little material passed through the porous gravel pack

Fluid Loss Improvements

Fluid Loss Testing Results

Slurry	Fluid Loss Results @ 500psi	Blow Out
15.8 ppg Low Fluid Loss Slurry	24 mls/30mins	-
RadiLock 1.8mm (0.5#/sk) in Low Fluid Loss Slurry	16 mls/30mins	-
RadiLock 3.0mm (0.5#/sk) in Low Fluid Loss Slurry	16 mls/30mins	-
15.8 ppg Neat Slurry	API Cal – 712 mls/30mins	1 min
RadiLock 1.8mm (0.5#/sk) in Neat Slurry	API Cal – 387 mls/30mins	2 mins
RadiLock 3.0mm (0.5#/sk) in Neat Slurry	API Cal – 388 mls/30mins	2 mins

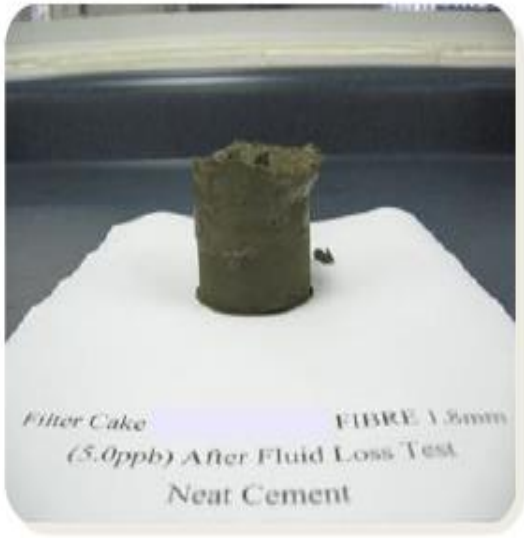
Using a 325 mesh screen in the fluid loss cell, we tested a low fluid loss cement slurry without the fibers, which showed a fluid loss of 24 mls/30 mins. Using the RadiLock fibers in the cement slurry, there was a significant decrease in the fluid loss to 16 mls/30 mins. RadiLock fibers help to form a mesh that prevents fluid loss.

We also tested a neat cement slurry without fibers using a 325 mesh screen resulted in a Fluid Loss result of 712 mls/30mins. Using the RadiLock fibers, we were able to decrease the filtrate to 387 mls/30 mins, almost by 50%. There is definitely a clear indication of bridging being caused by the fibers.

Filter Cake Stability

Dehydrated Cement Slurry Filter Cake

- RadiTeck 1.8mm
  Loading: None
- Results: Brittle Cake



Dehydrated Cement Slurry Filter Cake

- RadiTeck 1.8 mm
  Loading:
  0.25 - 1 lbs./sk.
- Results: Stable Cake

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Mechanical Application and Benefits

Mechanical Properties

Dosing Level: 0.25-0.50 pounds per sack of cement

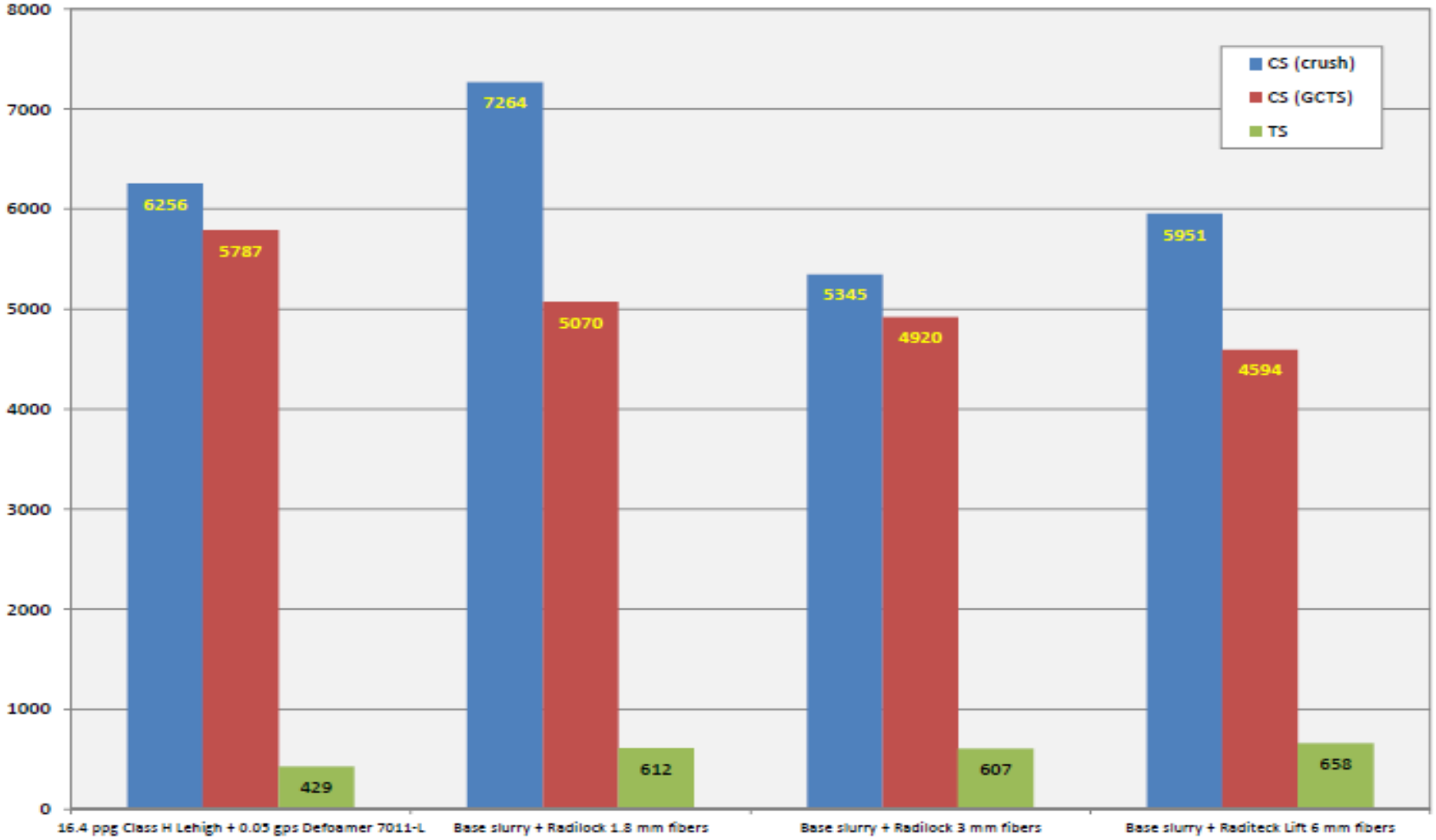
Benefits:

- Physical Bond creates a fiber matrix within cement
- Tensile strength improved by >50%
- Decrease in compressive strengths
- TS:CS ratio increased by >70%
- Young's Modulus improved by 10-20%
- Flexural modulus improvements
- Improvement in Poisson's Ratio

Mechanical Data

Slurry Design	CS (crush)	CS	TS	Flexural Modulus	Anelastic Strain	TS:CS	Poisson's Ratio	Young's Modulus
NEAT - 16.4 ppg Class H Lehigh + 0.05 gps Defoamer 7011-L	6256	5787	338	1777	7.69E-06	0.07	0.206	2100000
FIBERS - Base slurry + 0.5 lb/sk Radilock 1.8 mm fibers	7264	5070	612	1806	8.11E-06	0.12	0.225	1980000
FIBERS - Base slurry + 0.5 lb/sk Radilock 3 mm fibers	5345	4920	607	1854	5.16E-06	0.12	0.212	2070000

Mechanical Properties, psi



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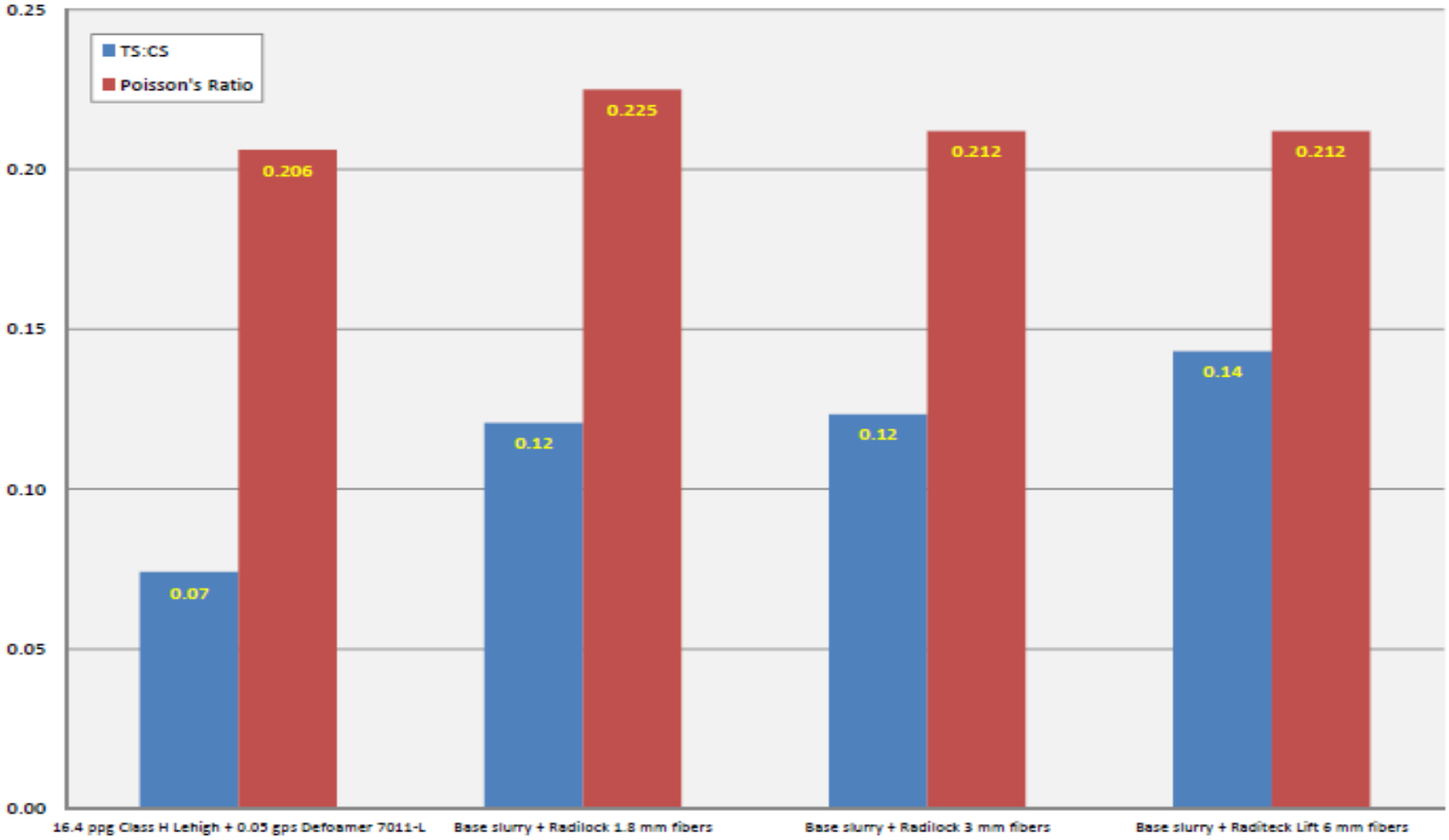
Poisson's Ratio & TS/CS



RadiLock vs. Competitive Fiber Technology Fiberglass

- Addition of Fibers
  - RadiLock 3mm – can be added into dry blend or hand dosed.
  - Fiberglass added into slurry in the mix tub (hand dosed).

- Recommended Loading Levels
  - RadiLock 3mm – recommended loading of 0.25#/sk (or 0.5-2.0#/brl)
  - Fiberglass is recommended at addition rates (claimed) of 5-15#/brl

- Effective Properties for Cementing
  - RadiLock 3mm – Bonds to cement and matrix providing LCM & Mechanical properties, as well as other properties reviewed above.
  - Fiberglass does not bond to cement/slurry and provides no additional benefit.

- Fiber Count – Fiberglass – N/A / RadiLock – 1.3B fibers
- Aspect Ratio – Fiberglass – N/A / RadiLock – 5000:1
- Thermal Stability – Fiberglass – 600F / RadiLock – 600F

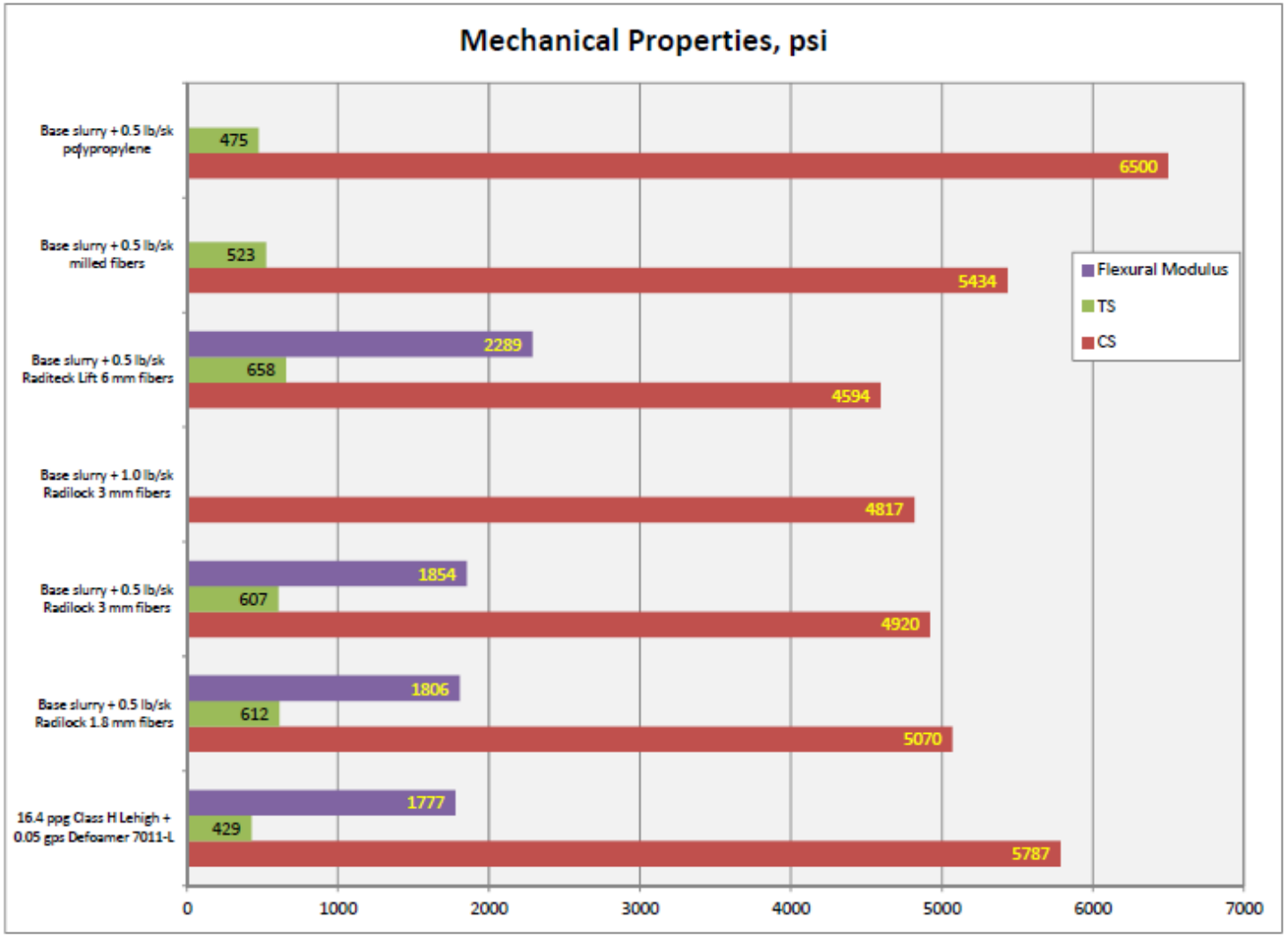
RadiLock vs. Competitive Fiber Technology – Polypropylene

- At equivalent loading levels, RadiLock fibers provides 30-40% impovements in mechanical/tensile properties
- At equivalent loading levels, RadiLock fibers offer 10X the number of fibers:
  - 1# of 3mm RadiLock - 1.3B fibers
  - 1# of PP 3m - ~160M fibers
- RadiLock fibers bond with the cement through ionic & chemical bonding, where the PP fibers are inert objects that provide very little bonding
- Recommended loading levels and price savings allows cementers to fill the slurry with other fillers/additives, much lower in pricing.
  - Recommended loading levels of the RadiLock 3mm - 1/4-1/2# per sack to maximize the benefits, although can be run lower.
- Improvements in bond logs and return to surface properties, due to fiber count and carrying/suspension properties of the RadiLock 3mm fiber.
- Better bridging where losses occur and the ability to place more cement where it's needed.

Additional Benefits vs. PP Fibers

- Ability to dry blend the RadiLock 3mm, where the competitive PP fiber have issues loading in the bulk plant
- Improved dispersion (dry and liquid) with the RadiLock into the cement matrix
- Thermal stability of the RadiLock is >600F, while the PP is around 250F before it begins to degrade/melt

Mechanical Properties vs. PP



Fiber Volume Difference

35 Grams of RadiLock Fibers in 2000 mL of Fluid

Approximately 61 Million Fibers (3mm fibers)

35 Grams of Polypropylene Fiber in 2000 mL of Fluid

Approximately 3 Million Fibers (12mm fiber)