

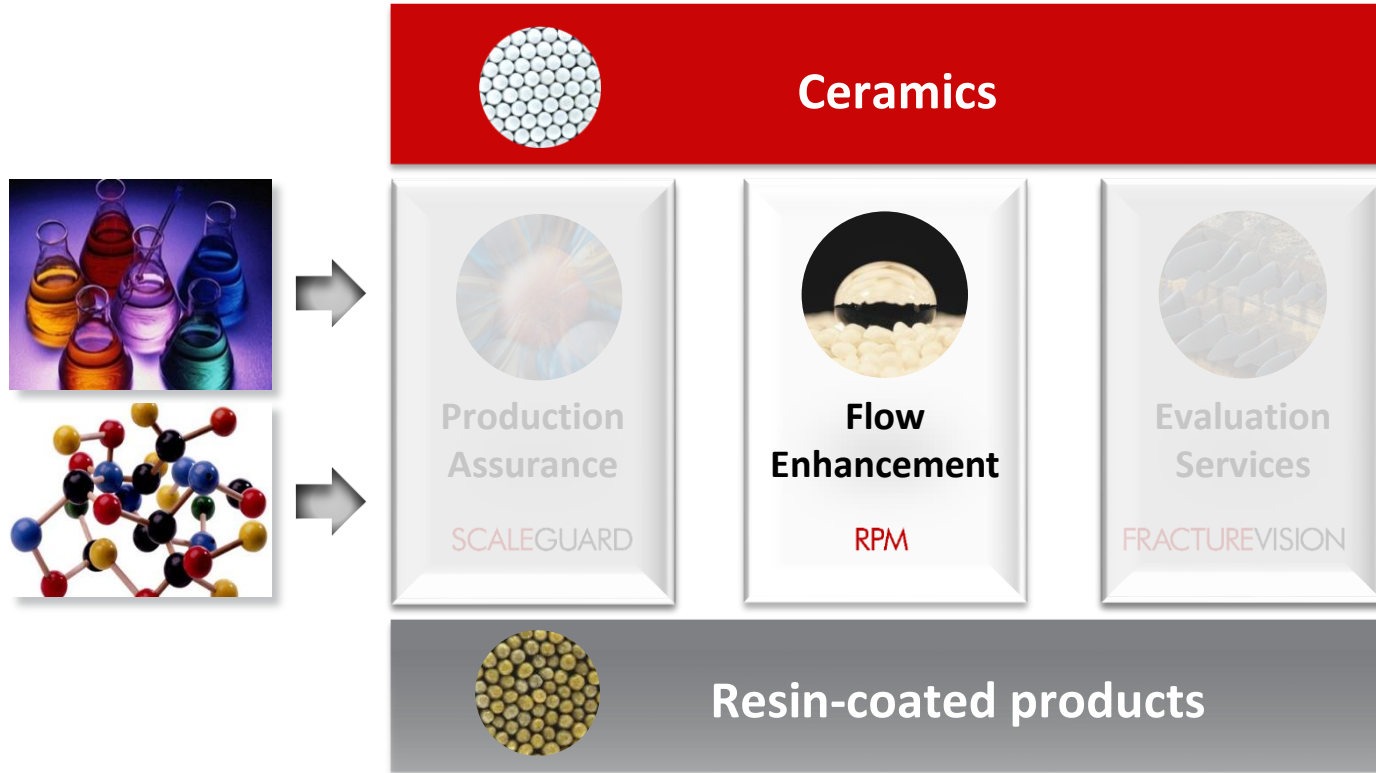
RPM

Relative Permeability Modification Technology

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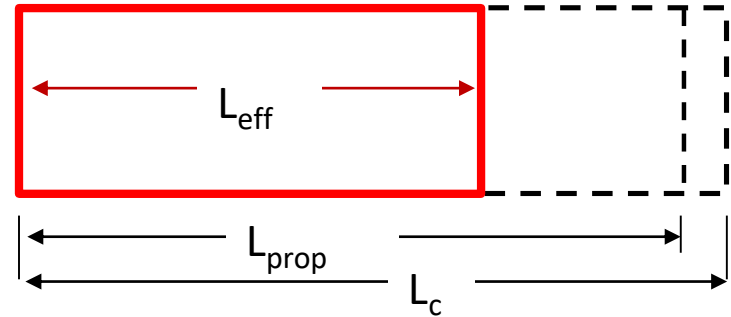
Global Engineering Advisor

Proppant-Delivered Technology Platforms



Fracture Flow Concerns

- Proppant pack gel damage
- Condensate banking
- Effective frac parameters significantly lower than designed
 - Fracture half length
 - Fracture conductivity

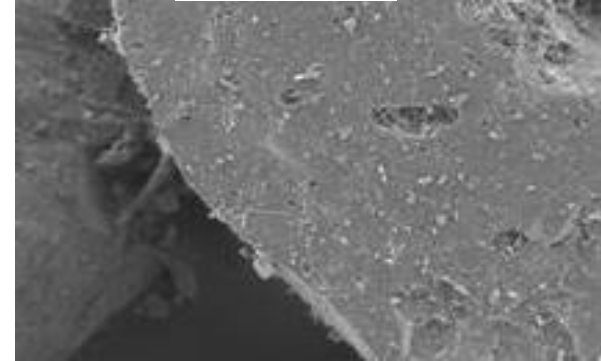


Flow Enhancement - RPM Technology

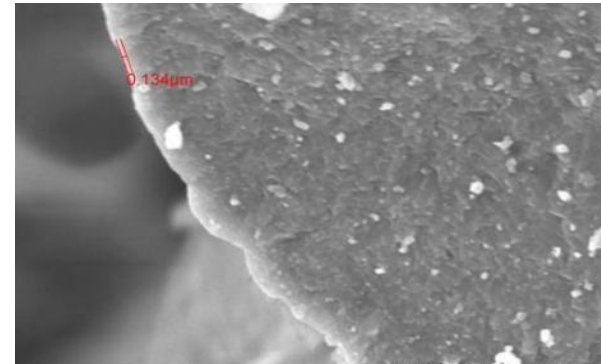
- RPM (Relative Permeability Modifier) is:
 - A thin permanent surface coating
 - Applied to every proppant grain
 - Unaffected by temperature or handling
 - Frac fluid compatible

- RPM (Relative Permeability Modifier) will:
 - Create a neutral wettability proppant
 - Reduce water saturation in proppant pack
 - Increase hydrocarbon permeability

Untreated

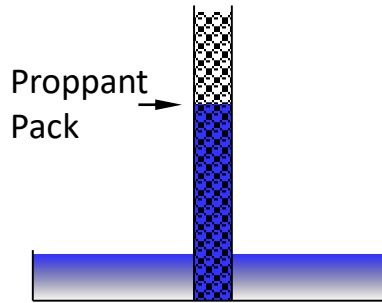
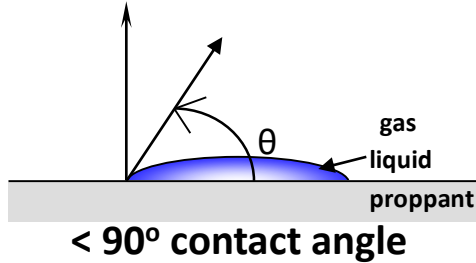


RPM Treated



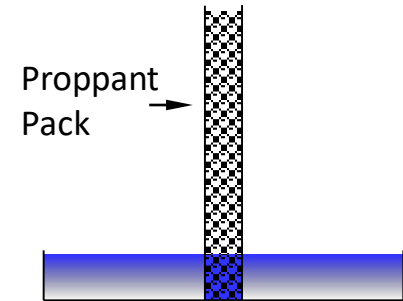
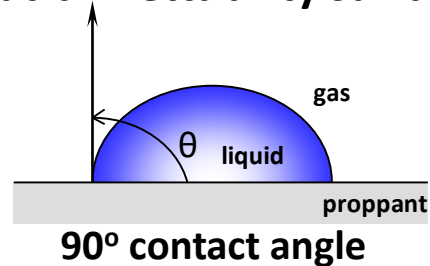
Treatment Creates Neutral Wettability

Most untreated proppants
are strongly water wet



Water wet surface draws fluid up
via capillary effect

RPM treatment creates a
neutral wettability surface



Treatment results in neutral
wettability on surface.

Advantage of Neutral Wettability Surface

Water droplet on **RPM**
treated
CARBOECONOPROP

$$P_{cap} = \frac{2\sigma \cos \Theta (90^\circ)}{r}$$

When $\Theta = 90^\circ$

Θ = contact angle

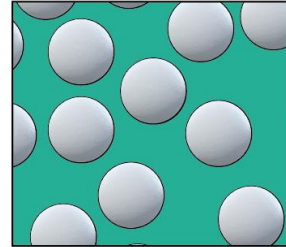


Advantage of Lower Capillary Pressure

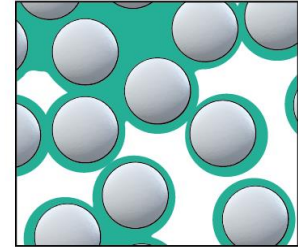
The neutral wettability reduces the trapped water and allows for load water to be more efficiently released

Untreated

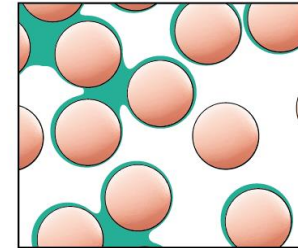
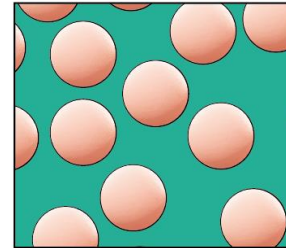
Before cleanup



After cleanup



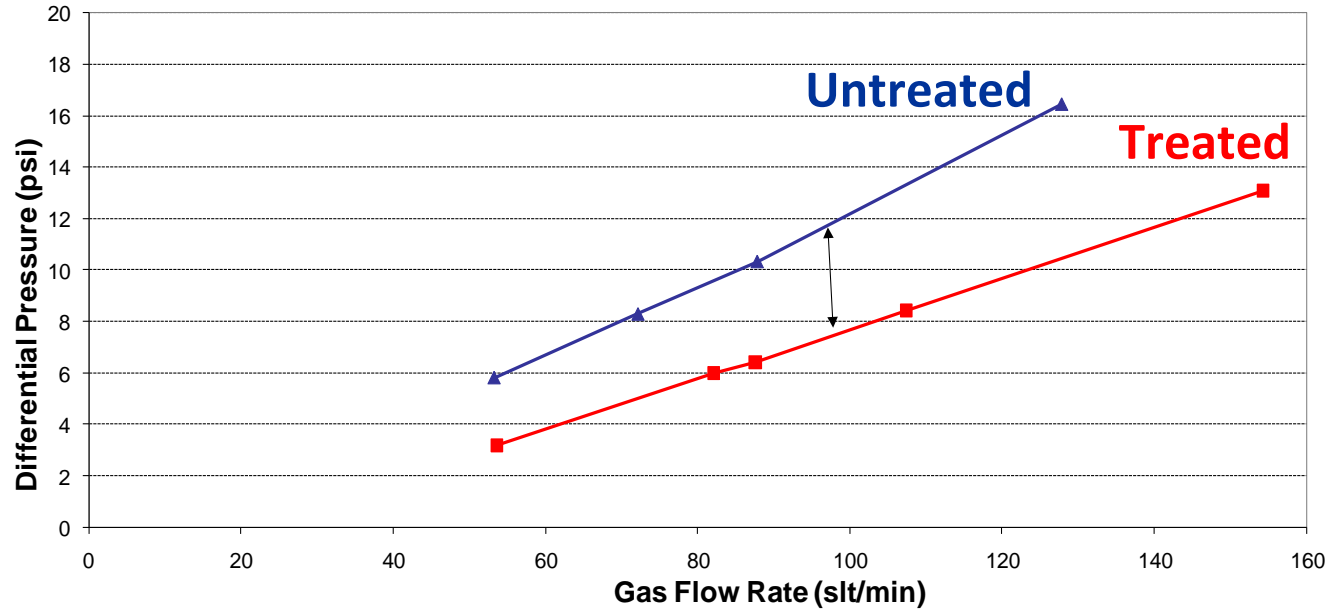
RPM Treated



Reduced Pressure Drop, Increased Permeability

Treated proppant has 35% lower pressure drop than untreated proppant

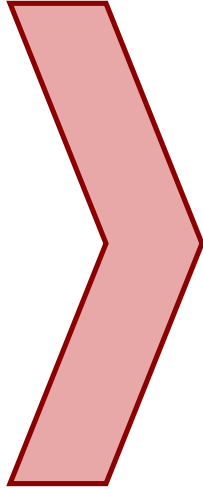
Lower pressure drop means higher permeability



Third Party Multiphase flow testing:
50 ml/min liquid flow rate,
300 psi, 180° F, 2#/ft², 2000 psi closure stress
Treated and Untreated 20/40 CARBOECONOPROP

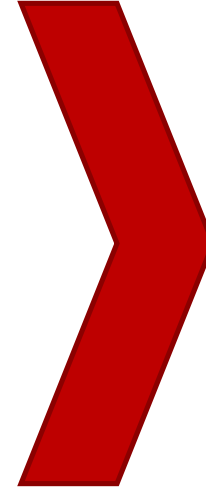
RPM Impact on Well Productivity

Neutral wettability leads to lower water saturation in the fracture



Longer effective fracture half length

Higher relative permeability to hydrocarbons



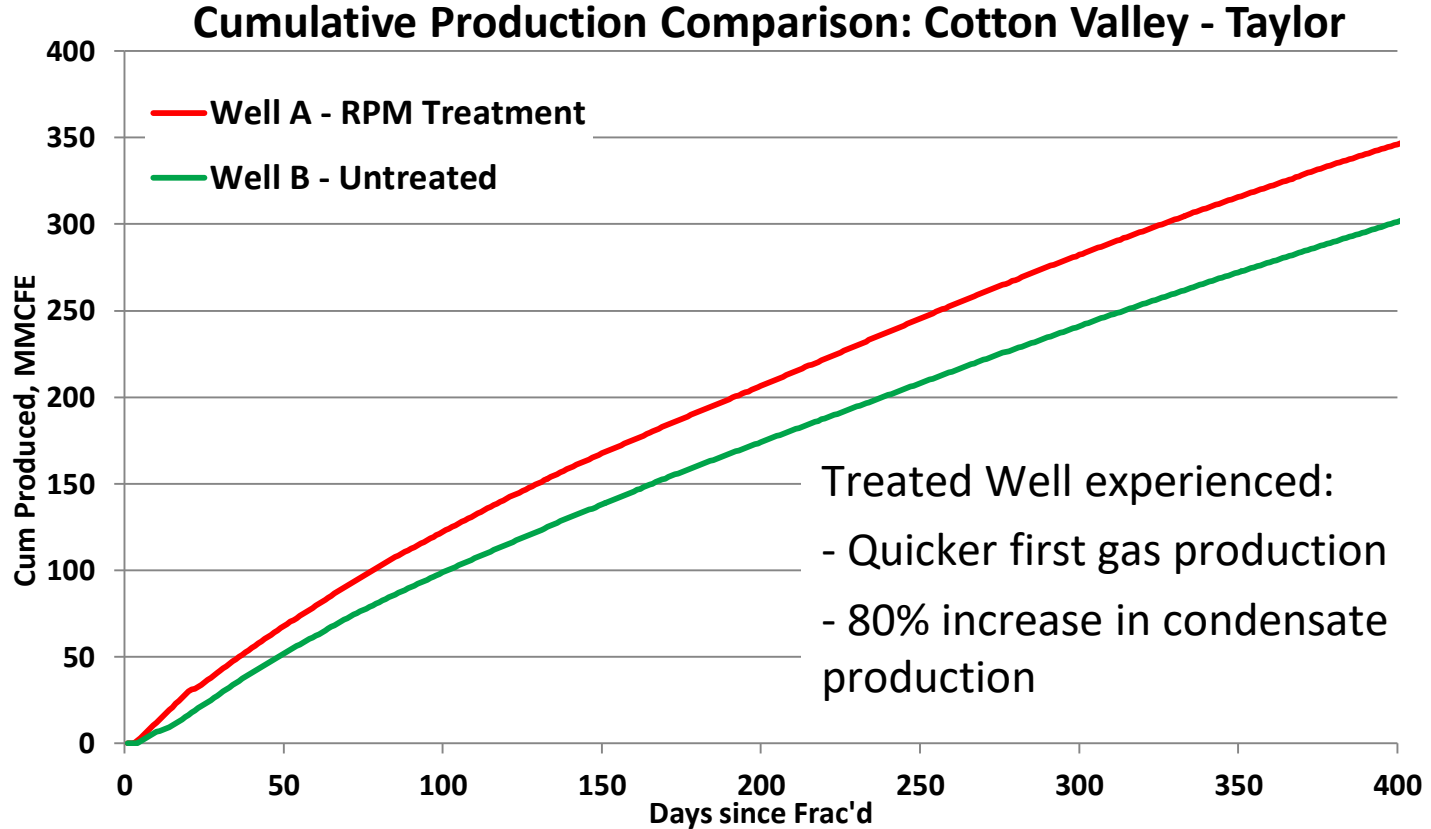
Higher

- production
- drainage area
- higher EUR

Field Performance

- RPM well producing 15% incremental production after 1 year
- \$215k incremental value*

*\$4/mcf, \$65/bo

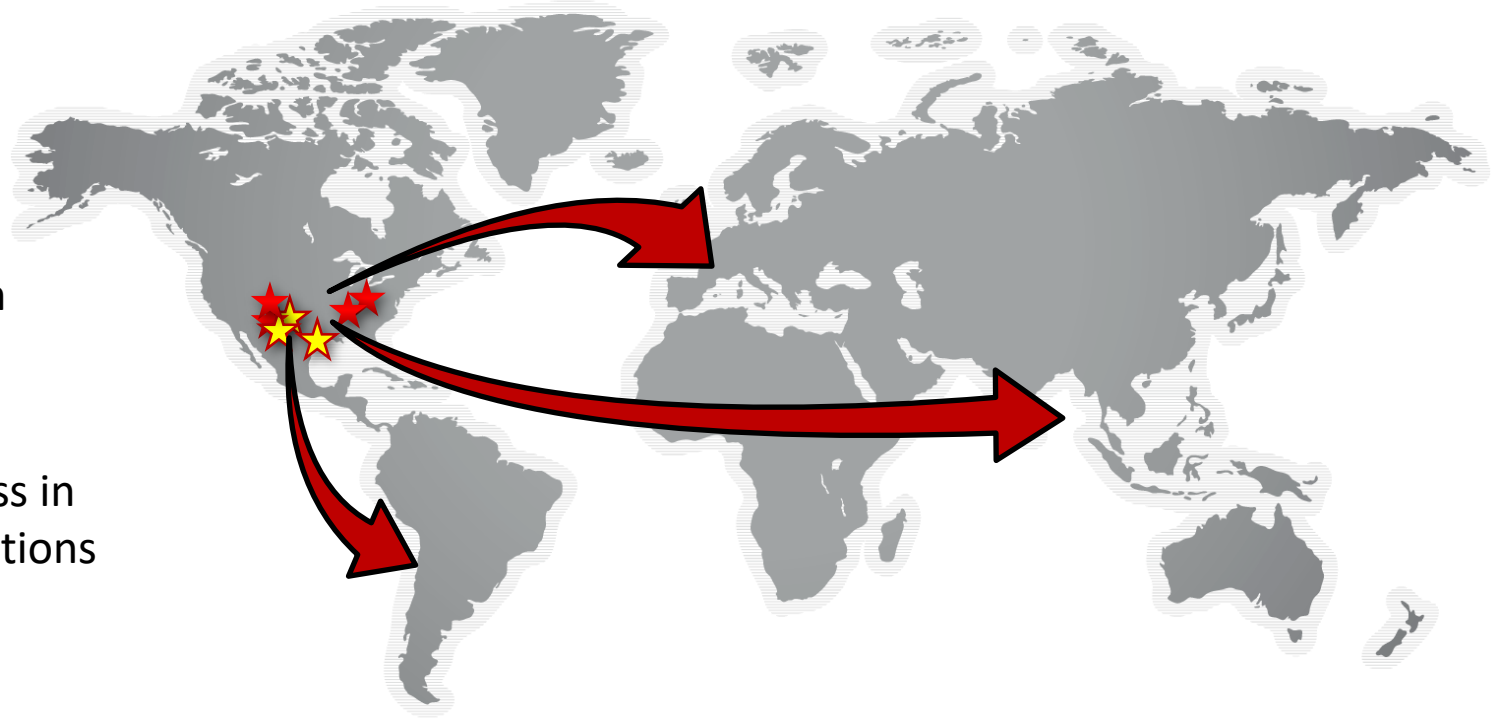


Current Field Applications

- Initial focus on vertical wells in North America
 - Observed 15% increase in productivity
- Midland Basin Success
 - Regular placement in vertical wells
 - First horizontal well
 - Currently highest producing well in their acreage
- Delaware Basin Interest
 - Horizontal well planned in Q4

Future RPM Applications

- Initial success in North America
- Expected success in fracture stimulations worldwide



Flow Enhancement - RPM Technology

- Coated ceramic proppant
 - Creates neutral wettability surface
- No impact on proppant properties
 - Frac fluid compatible, durable/permanent coating
- Virtually eliminates water capillary pressure in proppant pack
 - Improved fracture clean up & reduced water saturation
- Increased hydrocarbon production, effective frac length and ultimate recovery
 - Improved economics and higher return on investment
- Field proven

Thank you!

QUESTIONS?