Screen Selection for Standalone Screen Applications: State of the Art

Richard Hodge, Jamie Andrews, Rajesh Chanpura, Ezio Toffanin, Terje Moen, Mehmet Parlar

Outline

- Types of Sand Retention Tests
- Slurry Test Results Interpretations and Drawbacks
- Proposed
  - Method of Evaluation of Slurry Test Results
  - Laboratory Test Parameters for Slurry Tests
- Wire Wrap and Premium Mesh Screen Performances
  - Impact on SAS vs. OHGP Selection
- Conclusions

Slurry Tests vs. Prepack Tests

Slurry Tests

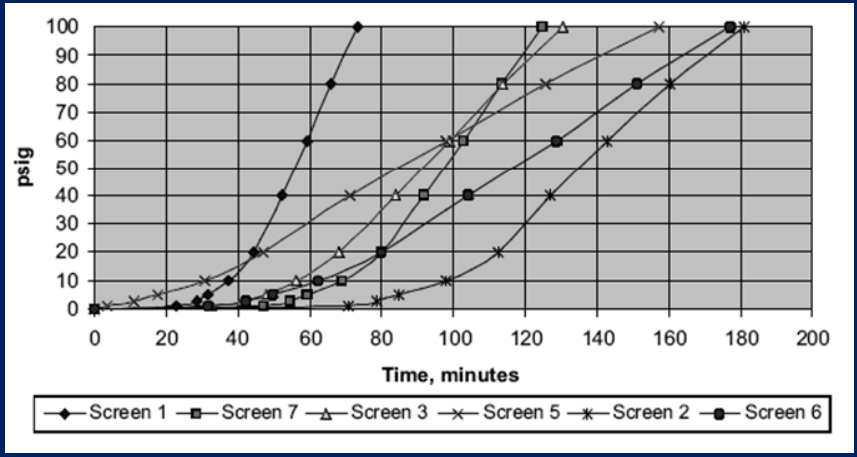
- Low concentration slurry (< 1 %)
- Sand pack forms during the test
- Slurry pumped at constant rate
- Simulates gradual rock failure

Prepack Tests

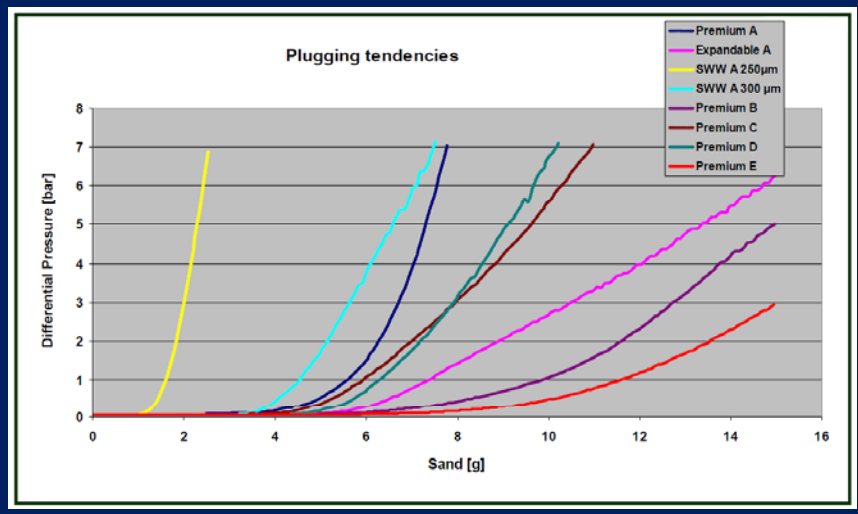
- High concentration slurry (~ 50 %)
- Sand pack formed initially
- Clean fluid pumped at constant rate or pressure
- Simulates hole collapse

- Sand produced vs. time or total sand produced (Measure of screen's sand retention efficiency)
- Pressure developed/flow rate vs. time (Measure of screen's "plugging" tendency)
- PSD of the produced solids

Typical Pressure Profiles from Slurry Tests



(SPE 75326)

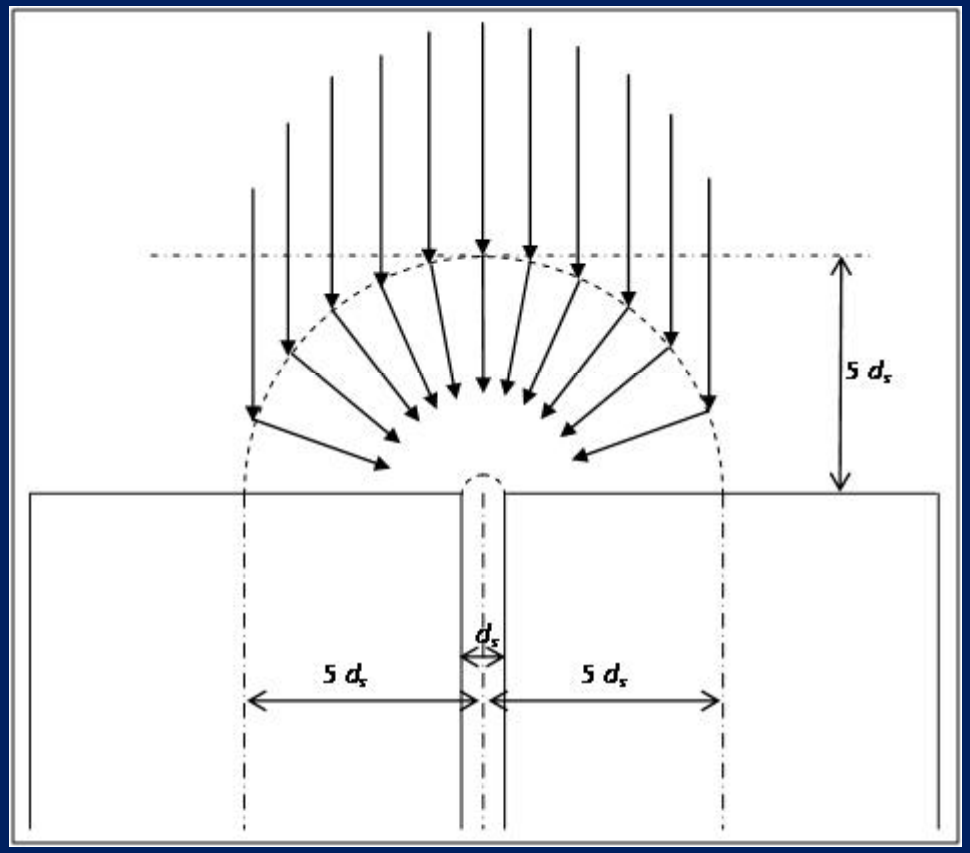


(SPE 107539)

Drawbacks of Current Interpretation of Slurry Test Results

- Screen selection based on relative ranking
- Even relative ranking not straight forward
  - Tests stopped prematurely
  - Effect of open flow area
  - Converging flow and Forchheimer flow effect
  - Flow rate ~ 1-2 orders of magnitude higher
- Almost always favors Premium Mesh Screen compared to Wire Wrap Screen

Converging Flow Effect on Pressure Drop (WWS ~ 10 % OFA)



$$\Delta P_{Conv} = \frac{\mu q_{slot}}{\pi K L} \ln\left(\frac{5d_s}{0.5d_s}\right)$$

$$\Delta P_{Linear} = \frac{\mu q_{slot}}{K(10d_s)L} 5d_s$$

$$\frac{\Delta P_{Conv}}{\Delta P_{Linear}} = \frac{2\ln(10)}{\pi} \sim 1.5$$

Influence of Flow Conditions in Sand Pack Around Opening on Pressure Drop

	Typical Laboratory Conditions	Typical Field Conditions
	Flow Rate = 200 ml/min Screen Coupon Diameter = 1.55 in Fluid Velocity = 0.27 cm/sec (Equivalent Field Flow Rate = 235,000 bpd) Fluid Density = 8.34 lb/gal	Flow Rate = 25,000 bpd Screen OD = 6.5 in Length = 1,000 ft Fluid Velocity = 0.029 cm/sec Fluid Density = 8.34 lb/gal
Fluid Viscosity = 187 cp Near Screen Permeability = 1 md	Ratio ~ 136	Ratio ~ 1,280
Fluid Viscosity = 1 cp Near Screen Permeability = 100 md	Ratio ~ 9 (Forchheimer flow accounts for 10% of observed pressure drop)	Ratio ~ 86
Fluid Viscosity = 1 cp Near Screen Permeability = 10 md	Ratio ~ 3 (Forchheimer flow accounts for 25% of observed pressure drop)	Ratio ~ 24

Proposed Laboratory Test Parameters for Slurry Tests

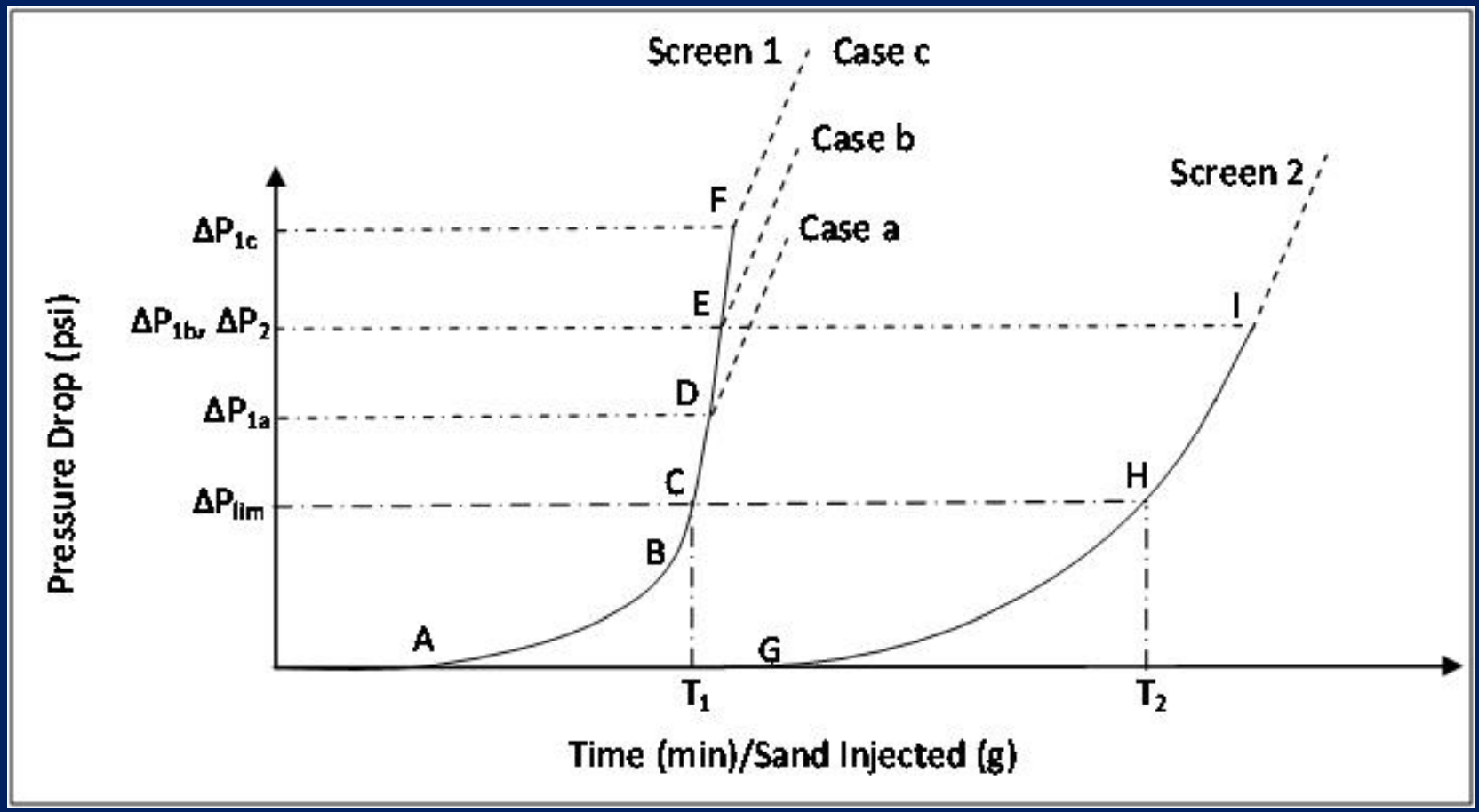
(Maintain Darcy Flow and Minimize Settling)

Test Parameter	Value
Flow Rate	200 ml/min
Screen Coupon Diameter (Excluding the seal)	1.5 in
Screen Area Open to Flow (Including the Wire/Mesh)	11.4 cm^2
Fluid Velocity	0.29 cm/sec
Fluid Viscosity	25 cp
Fluid Density (e.g., Cs-Formate, Zinc Bromide)	2.28 gm/cm^3 (19 lbs/gal)
Sand Concentration	0.5 gm/liter
Sand Density	2.65 gm/cm^3
Sand Volume Fraction in the Slurry	0.019 %
Sand Injection Rate	0.1 gm/min

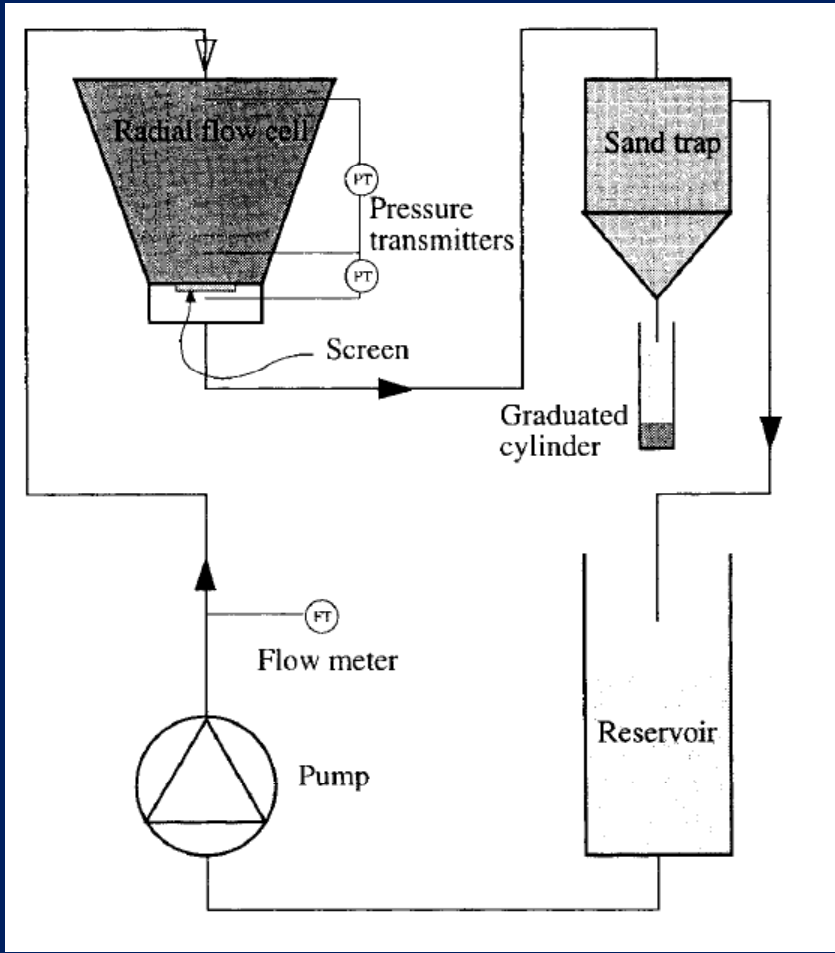
Proposed Laboratory Test Parameters for Slurry Tests

- For near screen permeability of 10 md, ratio ~ 27 (Forchheimer flow accounts for < 4 % of pressure drop)
- Fluid Velocity/Sand Settling Velocity ~ 6
- Test duration ~ 2.5-3 hrs
- Pressure drop through 0.25 in thick sand pack
  - ~ 3,100 psi (for 10 md near screen permeability)
  - ~ 300 psi (for 100 md near screen permeability)

Proposed Method for Evaluation of Slurry Test Results

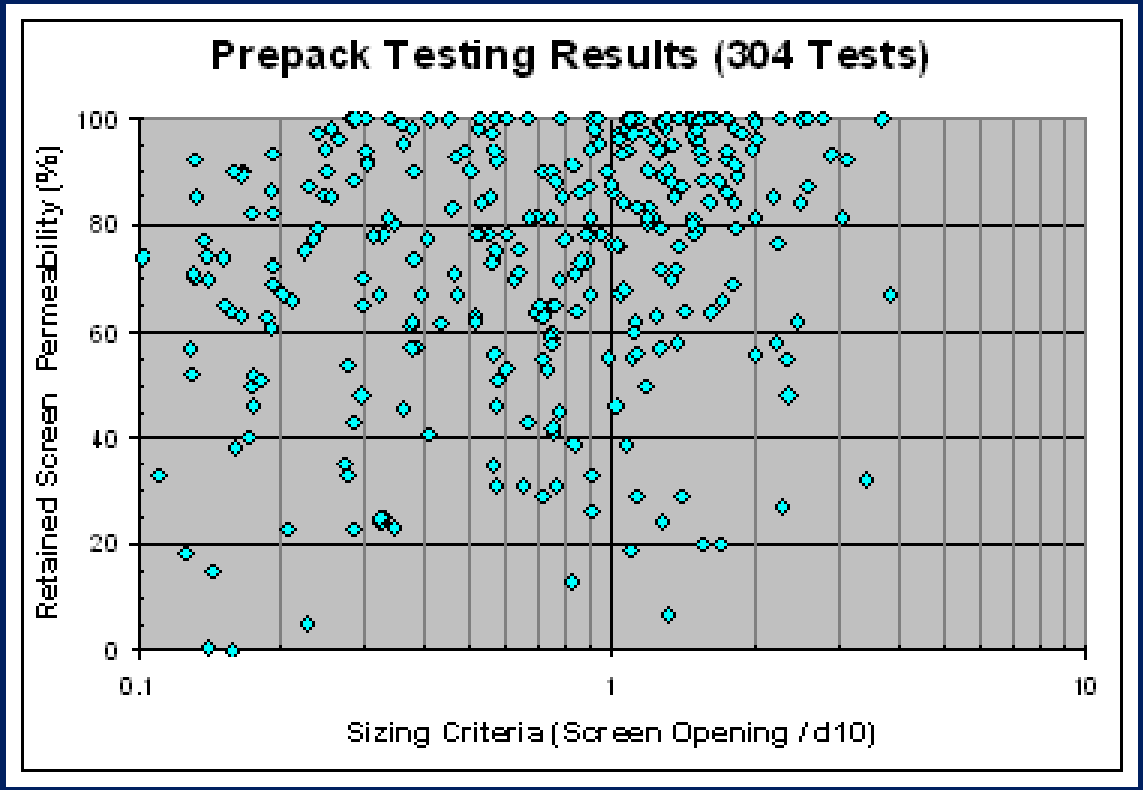


Upflow Test Procedure

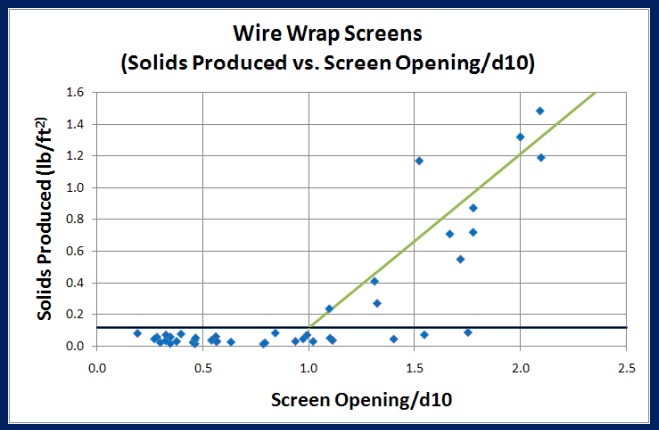


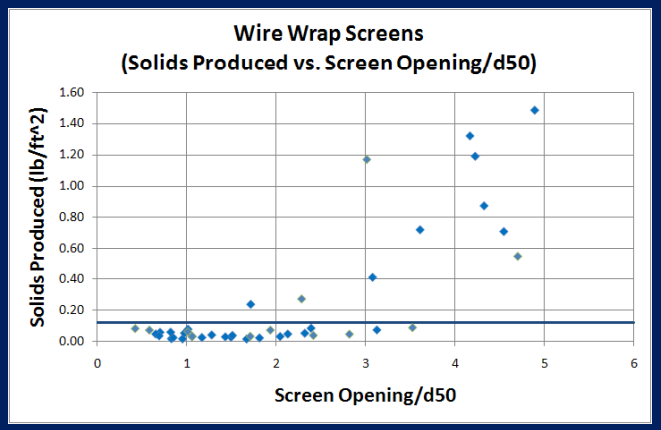
Schematic of Test Set up (SPE 31087)

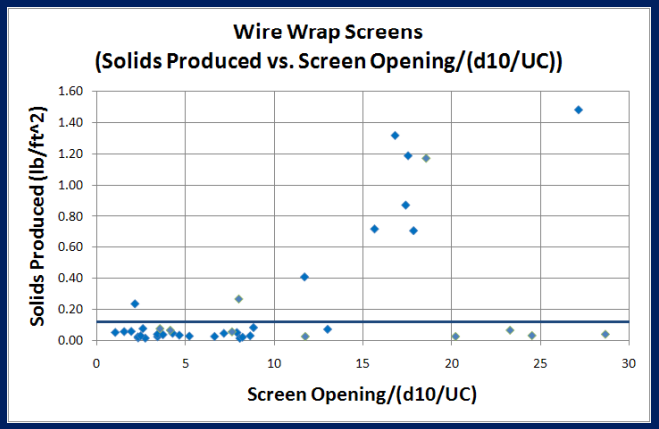
Screen Plugging Rarely an Issue with Formation Sand Alone

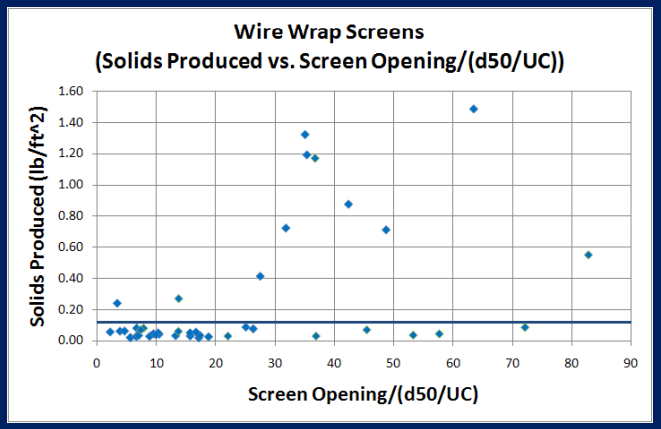


Wire Wrap Screen Performance (45 Tests)

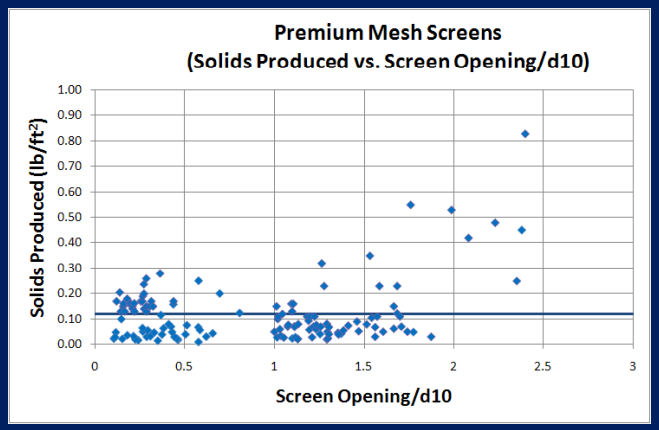


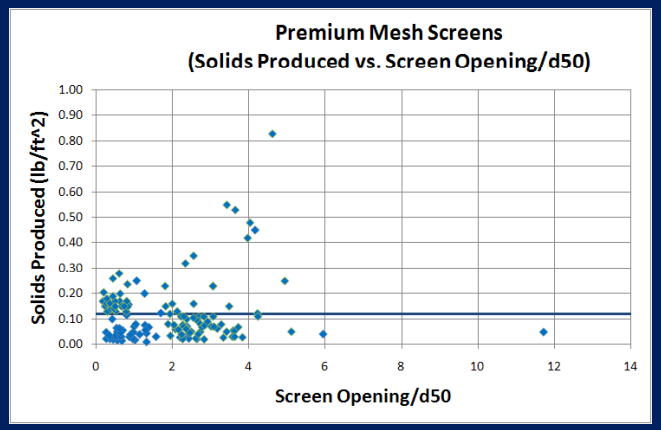


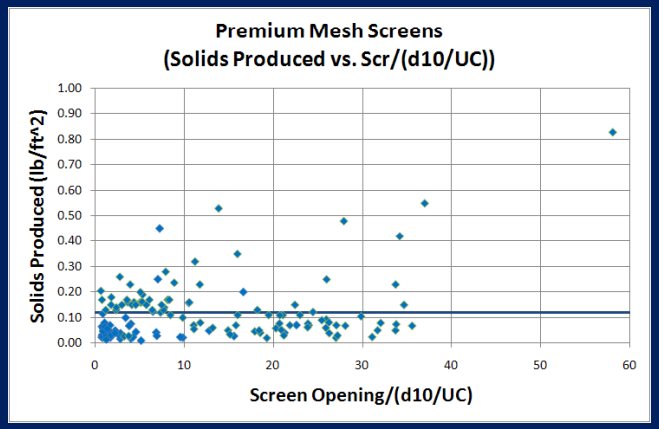


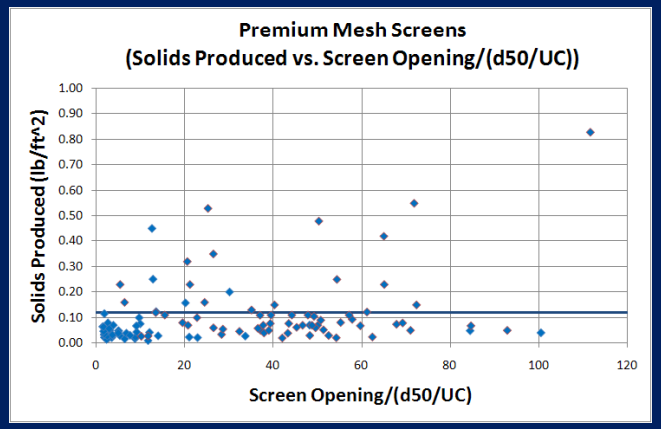


Premium Mesh Screen Performance (140 Tests)









Standalone Screen vs. Gravel Pack

- WWS – 30 of 45 data points with *UC* from 5-23 satisfies acceptable sand production criterion
- PSM – 70 of 140 data points with *UC* from 5-26 satisfies acceptable sand production criterion
- Commonly used criteria for SAS vs. GP (*UC* < 5, *SC* < 10, and sub 325 US mesh particles < 5 %) too restrictive
- However apart from PSD/screen combination, specific reservoir/well conditions (e.g., frequent shale streaks where isolation via packers may not be practical) also determines applicability of standalone screens or gravel packing

Conclusions

- Screen selection based on relative ranking of screen performances rather than absolute criteria
- Some laboratory procedures have bias towards wire wrap screens, and interpretation of some other laboratory tests favors premium mesh screens
- Proposed testing and interpretation methodology for slurry testing (accounting for converging flow and nonlinear Forchheimer flow effects) eliminates the drawbacks of the current screen selection methodology
- Severe screen plugging generally not an issue with formation sand alone
- Screen selection for standalone screen applications should be initially based on sand retention performance with only the final selection confirmed based on flow capacity

Conclusions

- For sizing wire wrap screens, currently used d_{10} criterion seems to always yield acceptable total sand production
- For premium mesh screens, there seems to be no correlation between experimental results and any combination of parameters typically used
- Some criterion that takes into account entire particle size distribution and accurate representation of screen opening geometry in premium mesh screens needs to be developed (e.g., using numerical simulations in conjunction with laboratory tests)
  - Until then, properly designed and interpreted laboratory tests are required to select screens for SAS applications
- Currently used selection criteria between standalone screens and gravel packing are too restrictive and that the application envelope of standalone screens can be expanded.

Questions?