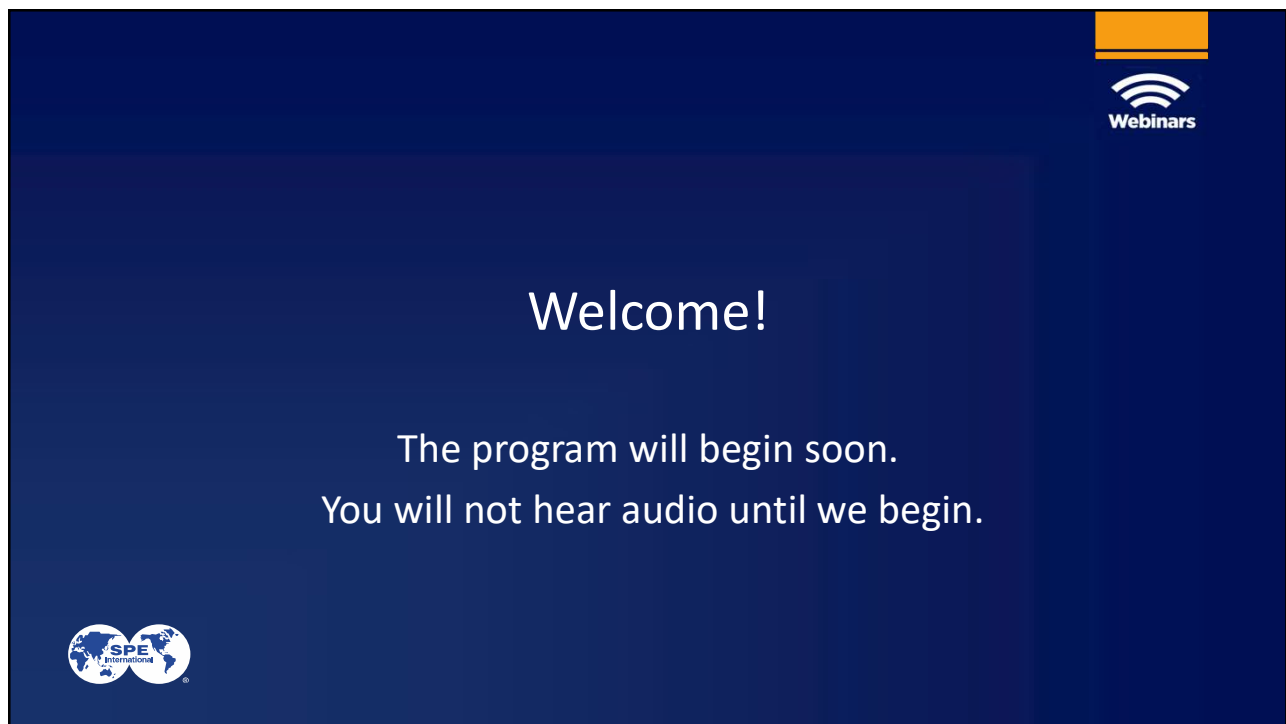




A dark blue rectangular slide with a white border. In the top right corner, there is an orange square above a white Wi-Fi symbol and the word "Webinars". In the center, the word "Welcome!" is written in large white font. Below it, two lines of white text read: "The program will begin soon." and "You will not hear audio until we begin." In the bottom left corner, there is a white logo for "SPE International" featuring a globe.

Webinars

Welcome!

The program will begin soon.
You will not hear audio until we begin.

SPE International





New Materials – Expanding Metal Alloy for Downhole Seals and Anchoring

Michael Fripp
July 21, 2023



Poll Question #1



What is your completions or production experience?

- a) 0-2 years
- b) 3-5 years
- c) 6-10 years
- d) 11-20 years
- e) More than 20 years



Poll Questions #2



What is your knowledge of “zonal isolation”?

- 1) None
- 2) Low
- 3) Medium
- 4) High



Poll Questions #3



What is your knowledge of “materials science”?

- 1) None
- 2) Low
- 3) Medium
- 4) High



Technology Drivers



- Technology driving future of completions



Material Science



Telemetry



Sensors



Digitalization

- New materials enable new solutions to classic challenges



Critical Application



- Zonal isolation enhances recovery
 - Allows more targeted stimulation
 - Allows more balanced production with ICD and AICDs
 - Allows more control with Intelligent Completions



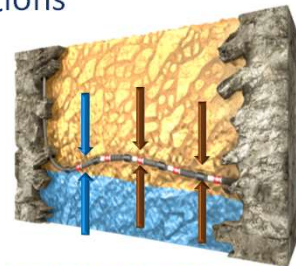
Open hole isolation in multistage fracturing



Critical Application



- Zonal isolation enhances recovery
 - Allows more targeted stimulation
 - Allows more balanced production with ICD and AICDs
 - Allows more control with Intelligent Completions



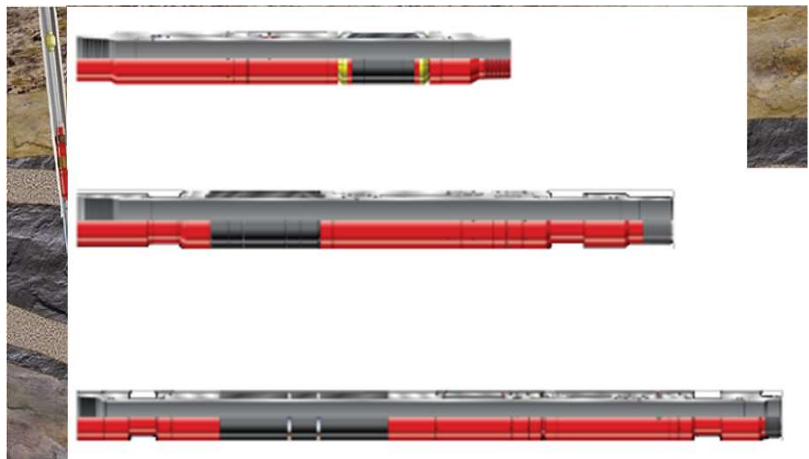
Autonomous Inflow Control Devices



Classic Solutions



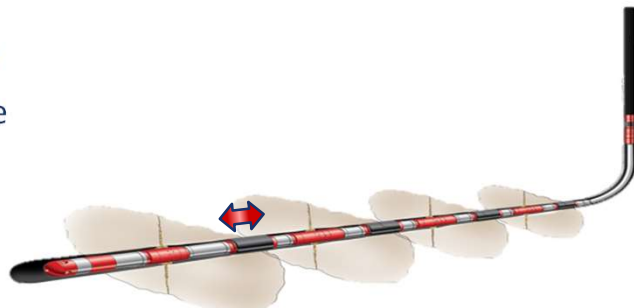
- Swellable rubber
- Inflatable packers
- Open hole packers



Classic Challenges



- Challenges for zonal isolation
 - Getting to target depth
 - Setting time and complexity
 - Stability at high temperature
 - High salinity environments
 - Anchoring forces
 - Reservoir coverage



Application Requirements for Zonal Isolation



		Avoids Bypass in Formation	High Salinity Brine	Anchoring Capability	Simple Rig Installation	Flexible Operations
Annular Barrier Packers	Inflatable Packers	●	●			
	Open hole Packers		●	▨		
	Swellable Packers	●			●	●



Expanding Metal Alloy



- Metal alloy expands downhole
 - Bonds with brine-based fluid
 - Transforms into a 'rock-like' material
- New expanding isolation system
 - Highly conformable
 - High differential pressure
 - Anchoring force holding capability



How Does it Work?



From **Metal**
to **Rock**



- Metal reacts with brine-based fluid
- Metal binds with water and increases volume
- Creates “rock” type material forming a competent seal and anchor



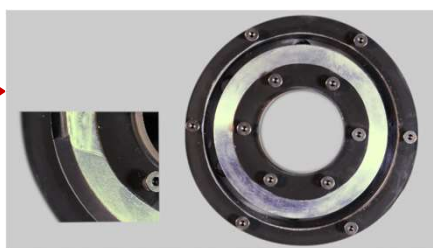
Setting Process



1 Reaction

2 Transformation

3 Expansion



Chemistry

- Electrochemical reaction between metal and brine
- Production 'building blocks' for sealing and anchoring



Setting Process



1 Reaction

2 Transformation

3 Expansion



Physics

- Compact 'building blocks'
- Form the rock-like material
- Form a seal and anchor

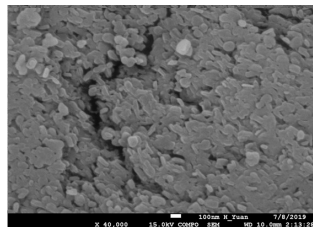
Setting Process



1 Reaction

2 Transformation

3 Expansion



Changing Material Structure

- Material expansion adapts to fill the void
- Grains of reaction by-product bond together



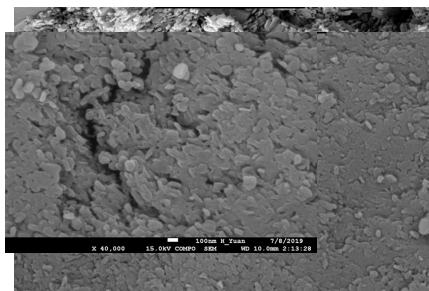
Setting Process



1 Reaction

2 Transformation

3 Expansion



Changing Material Structure

- Material expansion adapts to fill the void
- Grains of reaction by-product bond together



Aligned crystal structure

Poll Questions #4



What is your knowledge of “swellable rubber”?

- 1) None
- 2) Low
- 3) Medium
- 4) High



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Poll Questions #5



How important are non-elastomeric seals for you?

- 1) Not
- 2) Low
- 3) Medium
- 4) High

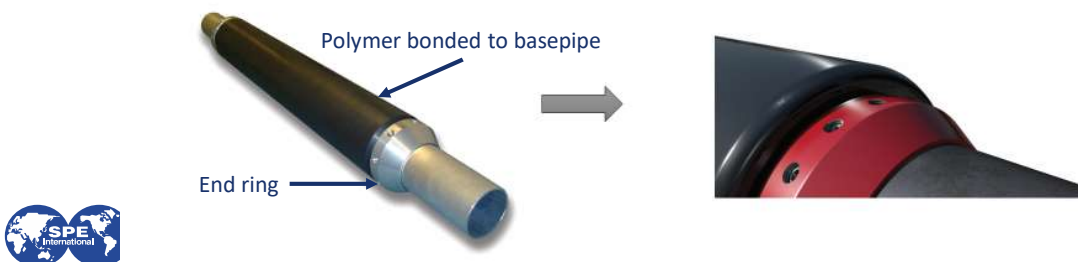


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Swellable Rubber



- Rubber designed to absorb fluid and swell into a void
- Formulations to absorb oil, water, or both
- Rubber softens as it swells

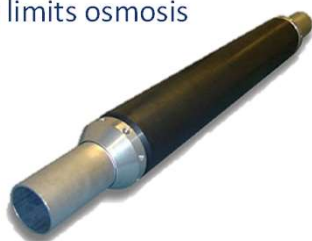


Difference with Swellable Rubber



Swellable Rubber Packers

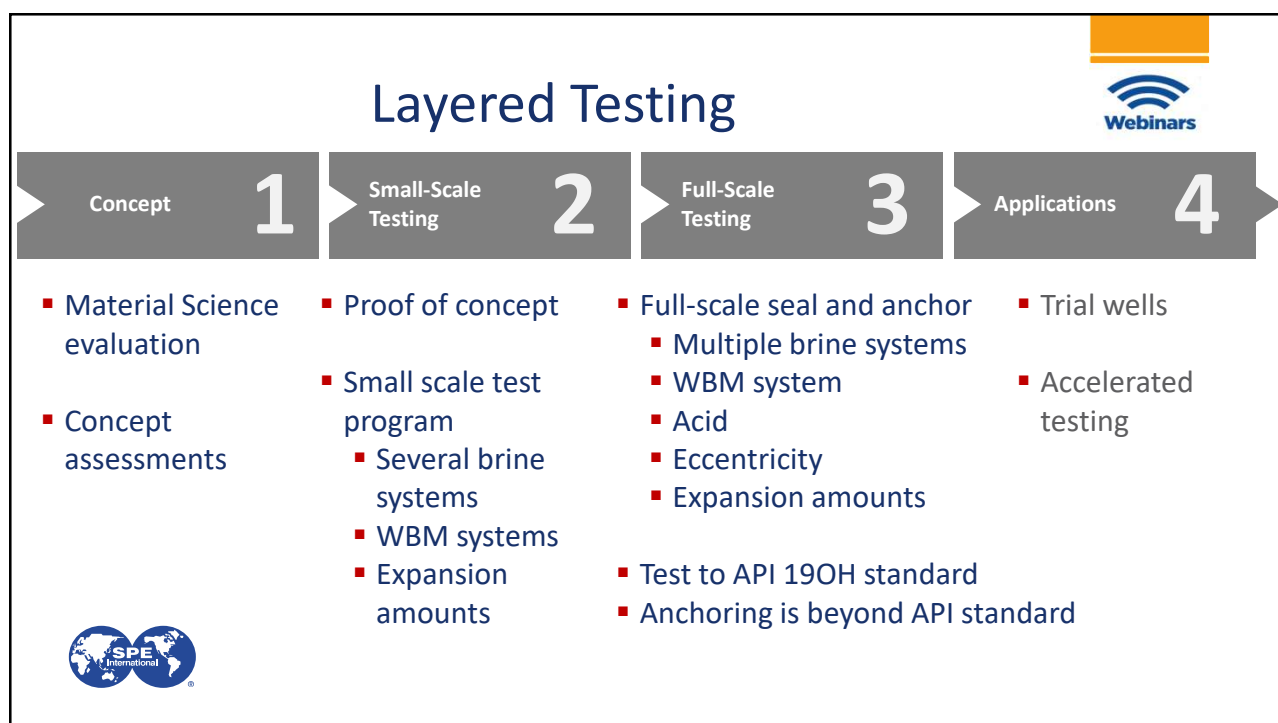
- Swelling based on physics, not chemistry
- Rubber absorbs fluids based on affinity to fluid
- High salinity limits osmosis



Expanding Metal Seals

- Expansion based on chemical reaction
- Fluids and temperature influence reaction

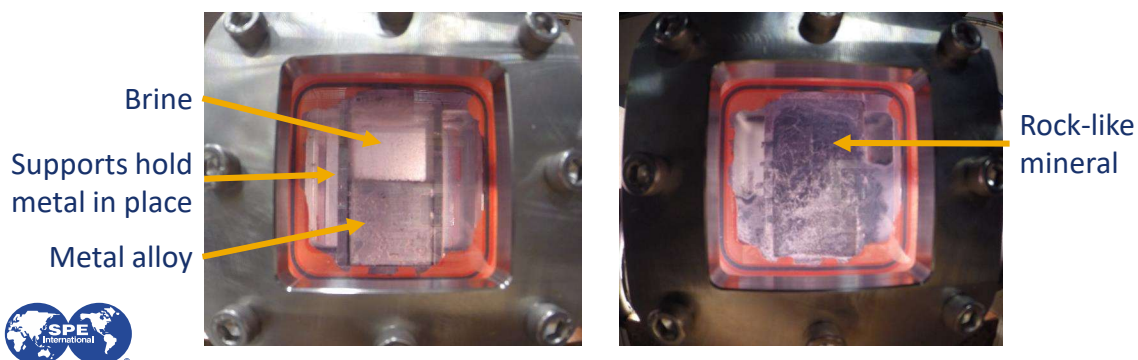




Metal Metamorphosis



- Visualization of expansion of 1-inch cube in brine
 - Rock-like seal conforms into corners



Full-Scale Testing



- Expand metal in multiple configurations
 - Brine concentration, Brine salt type
 - Temperature, hydrostatic pressure
 - Wellbore cleanup processes
 - Expansion amounts



Full-Scale Testing



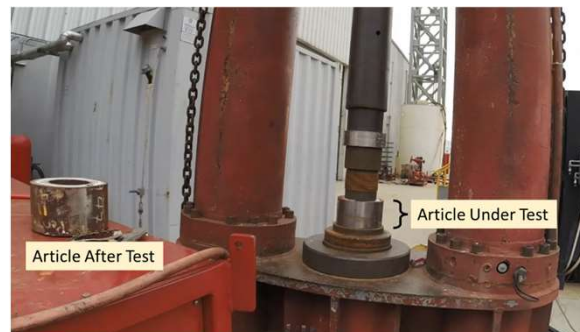
- Differential pressure test
 - Brine: Saturated KCl brine
 - Test temperature: 350°F (176°C)
 - Expansion amount: 28%
 - 1-meter section held 7,000psi differential
 - Pressure increases on longer sections



Laboratory Anchoring Testing



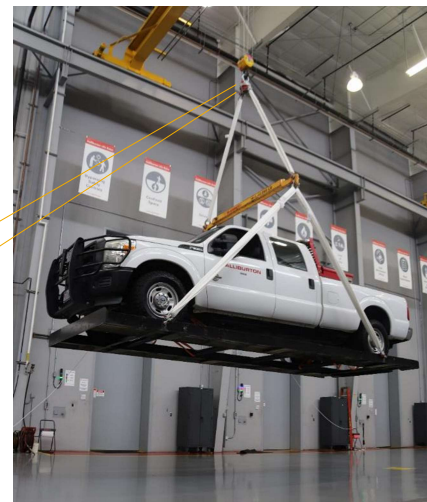
- Test anchoring performance after pressure loading
 - Full-scale anchor loads
 - Exceed 500,000 lb anchor
 - Apply reverse anchoring loads
 - Anchor on shorter sections
 - Cut 4"-long doughnuts
 - Anchoring load measurements



Anchor Demonstration



Anchoring Demonstration



Poll Questions #6



What are the toughest zonal isolation challenges?

- 1) Avoiding bypass through the formation
- 2) Sealing in high salinity brines
- 3) Ability to anchor the seal
- 4) Installation that is operationally simple
- 5) Flexibility in installation and operations
- 6) Time to initial seal



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Application Requirements for Zonal Isolation		Webinars				
		Avoids Bypass in Formation	High Salinity Brine	Anchoring Capability	Simple Rig Installation	Flexible Operations
		●	●			
			●	●		
		●			●	●
New Expanding Metal	Metallic Alloy	●	●	●	●	●



Conclusion



- Expanding metal alloy has operational simplicity of swellable elastomer with robustness of non-elastomeric seals with anchoring capability
- Solid metal alloy during installation
 - Slim profile and no moving parts
- Expands to form rock-like seal
 - Conformable seal
 - Robust to high salinity brine
 - Durable at high temperature



New Materials – Expanding Metal Alloy for Sealing and Anchoring



Thank you

- Coauthors: Rutger Evers, Stephen Greci, Brandon Least, Chris Pelto, Chris Rodriguez, Taylor Stein, Lori Wiltz, and Allan Zhong
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Questions?

