SPI Conformance Gel Applications in Geothermal Zonal Isolation

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Project Officer: William A. Vandermeer
Total Project Funding: $999,779
Date: 2015

Principal Investigator
Lyle D Burns

Tracker Name

Relevance/Impact of Research

- Challenges & Barriers or problems addressed by this project.
  - Geothermal Zonal Isolation (GZI) field efforts currently use mechanical means or cement to repair problems.
  - Current solutions are not always reversible - difficult to later re-enter a zone for production.
  - SPI gels could provide a reversible solution to this problem.
- Project impact on costs, performance, applications, markets or other geothermal energy development factors.
  - If cannot control zonal fluid loss, may need to abandon drilling.
  - SPI Gels can substantially lower the costs by performing zonal isolation and allowing reversible entry.

Relevance/Impact of Research Continued

- SPI gels – Project Innovation – Previously developed for EOR conformance control for water and CO_2 floods, sealing off casing leaks, and stopping water leaks in basements. Could SPI gels work in GZI at HT?
- New innovation – Develop a new initiator system for SPI gels to make more inorganic and tolerant to HT.
- SPI application success could solve problems and impact GTO's goals by:
  - Demonstrate 5 MW reservoir creation by 2020
  - Lower LCOE to 6 cents/kWh by 2030
  - Drive industry deployment of a targeted 100+ GW of EG

Scientific/Technical Approach

- Scientific approach to accomplish objectives derived from the literature and thought.
  - Well known R&D lab reported forming precipitate gels for GZI with colloidal silica and strong acids like in the 50's.
  - Positive – Created an inorganic product – HTHP Stable.
  - Negatives
    - No gel time delay
    - Poor quality gels
    - Never mentioned reversibility
- Can we develop a "next-generation" GZI technology improvement ready for pilot scale testing using SPI gels?
  - Know Sodium silicate is 3 times cheaper than colloidal silica and forms better SPI gels.
  - Polymer in SPI gel contributes to enhanced HT stability by reducing syneresis, ion sensitivity, and resiliency (elastic gels).
  - New SPI gel system is a silicate nano-particle/ mixed polymer gel with extensive hydrogen bonding.

Scientific/Technical Approach-Continued

  - What is the R&D impact to geothermal deployment – First chemical system in GZI while drilling wells that is reversible.
  - Initial SPI initiator systems were organic and would not have significant gel time delay at HT, but if they were inorganic they would not chemically degrade. But, how do we make inorganic time delayed initiator?
- Well, most significant development in this project is the inorganic initiator improvement making SPI gels suitable for geothermal and other new EOR gel applications.
- This approach allows us to develop a time delayed initiator system not based on initiator concentration, but based on acid proton availability with time called a Reduced Activity Acid (RAA)
- This innovates a product with Much More Value than originally planned.

Accomplishments, Results and Progress

Original Planned Milestone/ Technical Accomplishment	Actual Milestone/Technical Accomplishment	Date Completed
New Stable HT Polymer SPI gel	Accomplished – Cost to much	5-2013
New HMwt Polymer Initiators	None – Did not work	
New Inorganic Initiator	Reduced Activity Acid Initiator (RAA)	7-2014
New SPI Gel Initiator Economics	New SPI Gel RAA Economics	8-2014
None	SPI gel Time Delayed by Shear	8-2014
SPI Gel Reversibility	SPI Gel Reversibility	8-2014
SPI Gel Dynamic Tolerance 250C		Soon

Accomplishments, Results and Progress Continued

- Most significant technical accomplishments
  - New Initiator system, SPI gel is State of the Art
  - Gel formation can be delayed by shear w/o any gel damage
  - More Patent(s) Anticipated (Derived from other DOE Projects too)
  - Substantially more cost competitive than original SPI version.
  - Reversible
  - Dynamic work indicates gel firmness determined in the lab bench work creates a very large ΔP in the unconsolidated sand pack.
  - This large ΔP is >1,000 psi at a pump rate of 0.07 ft/day against the SPI gel in the pack.
- Milestones – Original vs Actual Concept in this project
  - Not always the same
  - Some don’t occur - ideas are path independent, but Some Do
  - Objectives and technical targets will be achieved for this project.

Accomplishments, Results and Progress Continued

- Technical Barriers
  - When we are the only ones performing R&D in an area –
  - It may not be a walk in the park
  - Manufacturers may not have equipment needed or knowledge
  - In this case, the metallurgy is pressure rated, but the sleeves and seals are not pressure rated or chemically (even to steam) tolerant.
- This is why we need to innovate and think. Also a good Technical Consultant with experience is a strong team asset.

Future Directions

- Deployment Strategy – Field Test or Other HT Applications
  - Project will end on or about Sept. 30, 2015.
  - Clean Tech Innovations will Meet Objectives as a Go Field Test
  - The Technology will be Ready for Field application – But have not seen appropriate funding opportunity.
  - Alternative, working on SPI Gel DOE CO_2 Sequestration SBIR Ph II Field Testing. Could invoke some applications here at HT.
  - Impact Technologies is Clean Tech Innovations Customer for all SPI gel commercialization work. Impact owns the patents.

Milestone or Go/No-Go	Status & Expected Completion Date
SPI gels function in GZI	Go Decision by Sept. 30, 2015

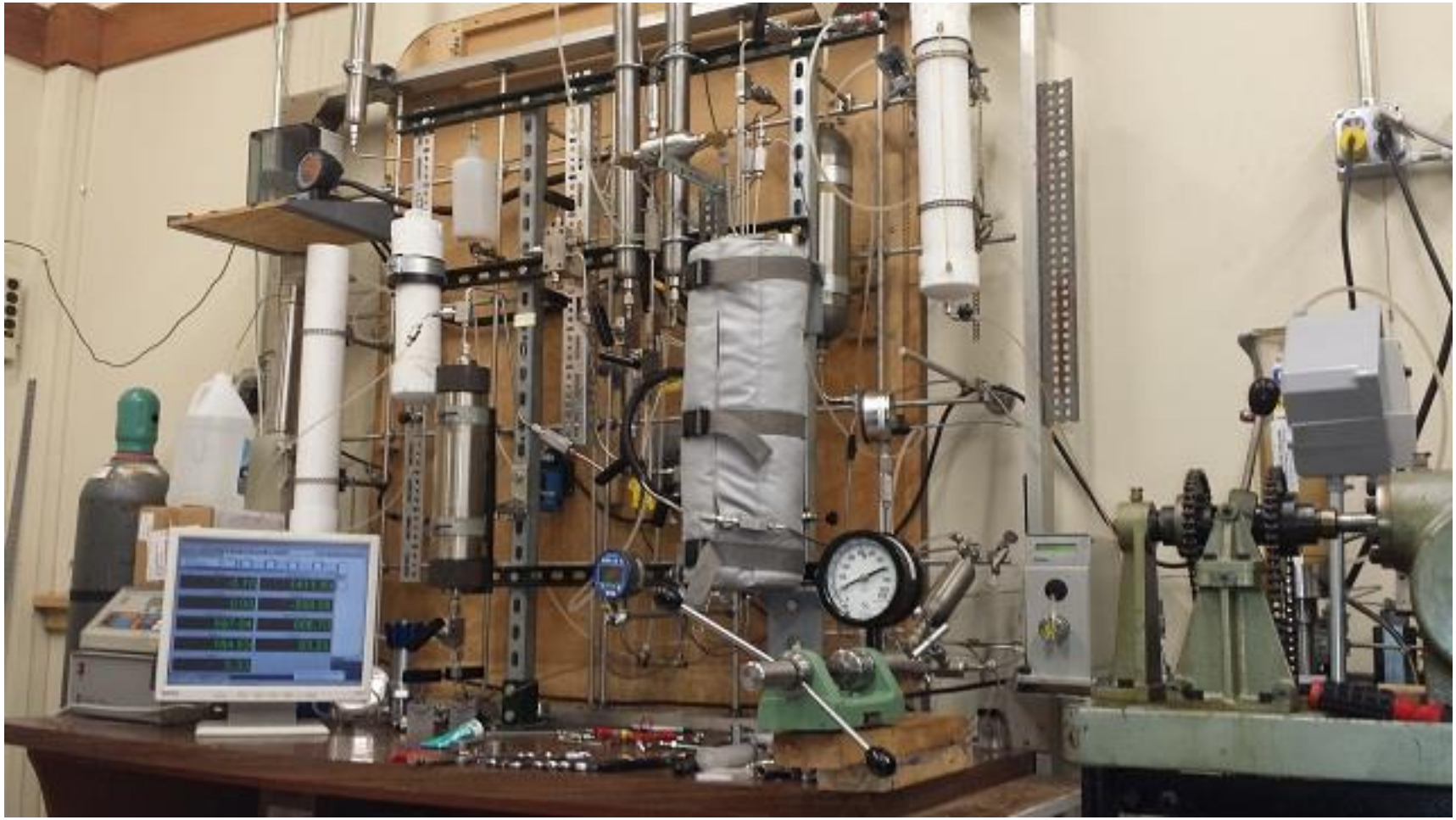
Mandatory Summary Slide

- We have developed a ”Next-Generation” GZI technology improvement ready for pilot scale testing using SPI gels.
  - SPI gel is State of the Art with the New Initiator system.
  - Gel formation can be delayed by shear w/o gel damage
  - Patent(s) Anticipated
  - Substantially more cost competitive than original SPI version.
  - SPI Gels are reversible using a simple procedure.
  - Dynamic work to date has shown that the gel firmness determined in the lab bench work creates a very large ΔP in the unconsolidated sand pack.
  - ΔP is >1,000 psi at a pump rate of 0.07 ft/day against the hard SPI gel in the pack.
- SPI gels for GZI need to be field tested for commercialization.

Additional Information

- Mechanistic Understanding Provides the Know-How to Build Successful Chemical Strategies
- And
- The Scientific Approach to Accomplish the Objectives Can Be Derived from the Literature and Thought.
- Thank You

Additional Information



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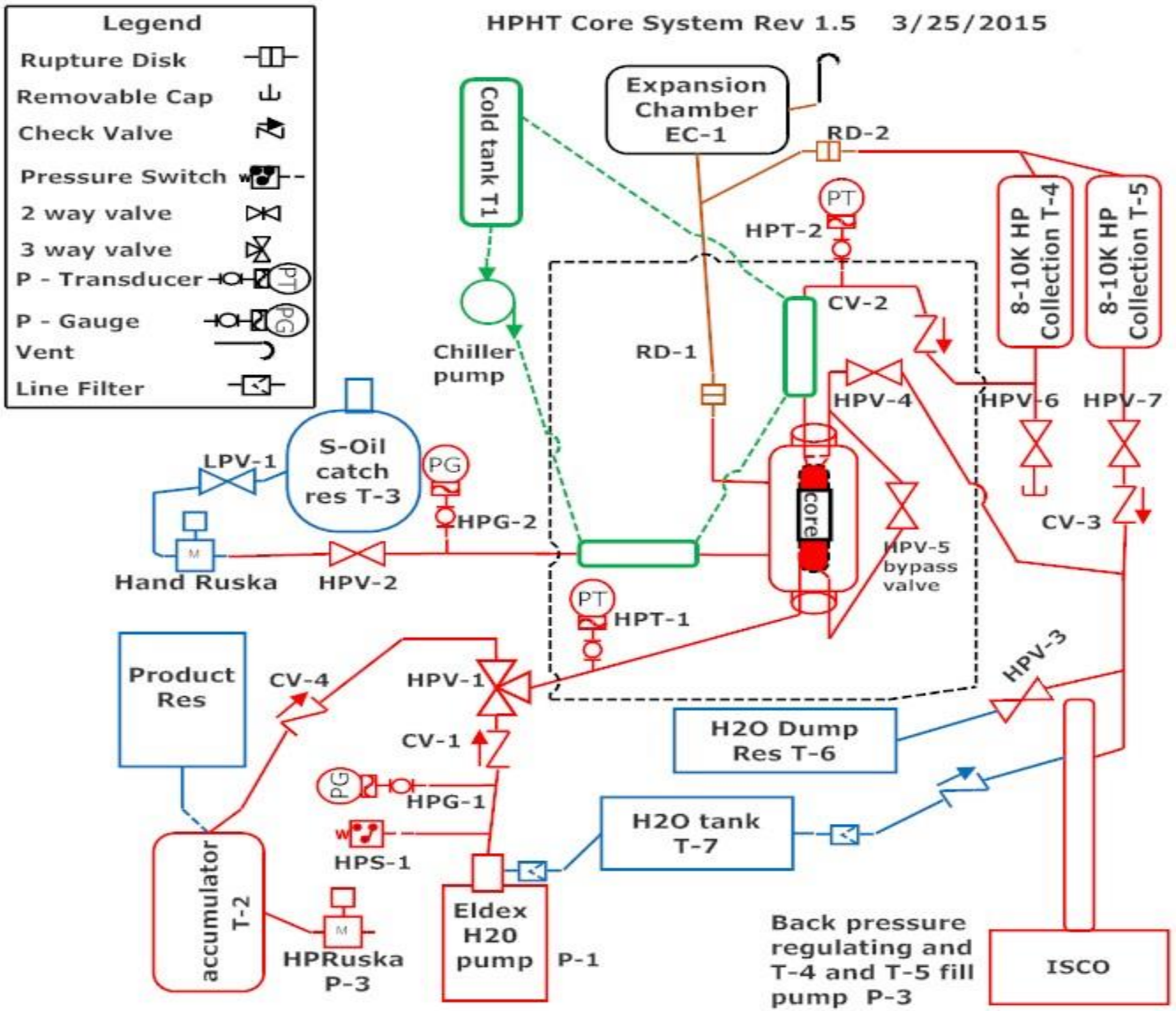

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