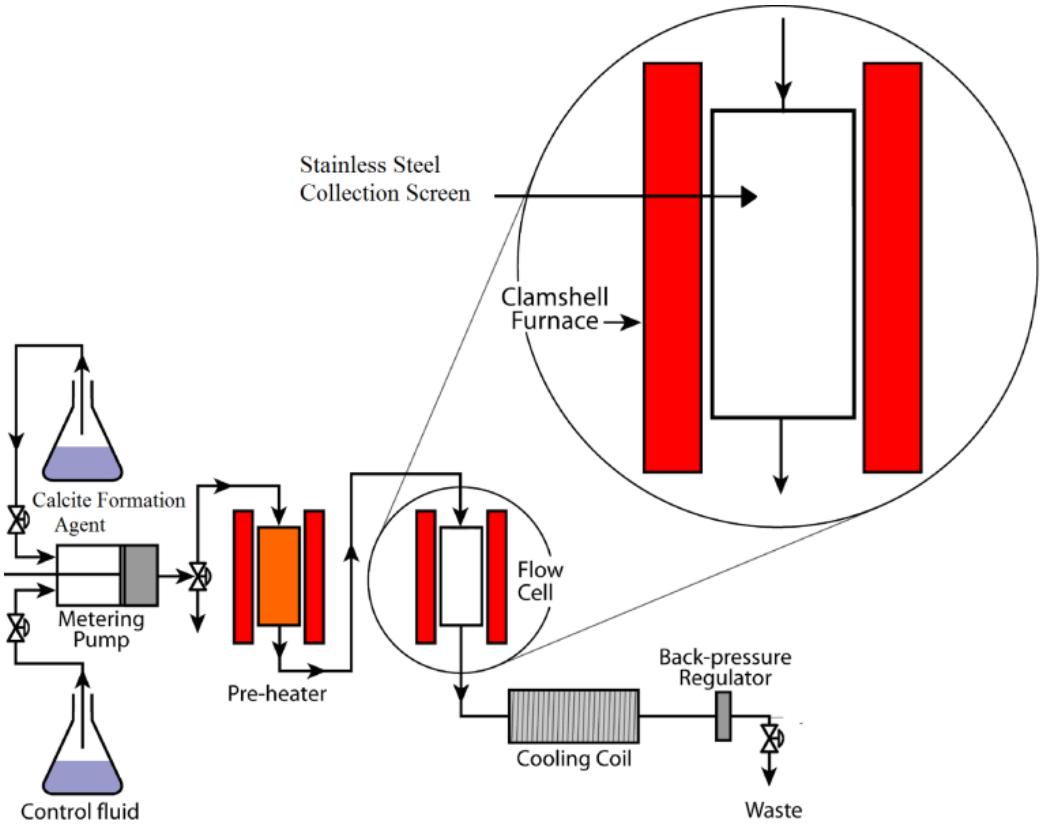


Temporary Bridging Agents for Use in Drilling and Completions of EGS

May 18, 2010

Principal Investigator – Larry Watters
Presenter – Jeff Watters
CSI Technologies LLC

Track Name

Overview

- Project Title – Temporary Bridging Agents for Use in Drilling and Completion of Engineered Geothermal Systems
- Timeline
  - Project Start Date – May 1, 2010
  - Project End Date – May 1, 2011
- Budget
  - Total Project Funding - $1.352 Million
  - DOE Share - $766,600
  - Awardees share - $566,600
- Partners
  - AltaRock Energy
  - University of Utah

Relevance/Impact of Research

Objective of Project:

Develop materials or systems that bridge to seal or divert flow from fractures existing while drilling EGS wells or in injection formation and that eventually decompose thereby leaving the fractures unsealed and undamaged

Problem:

- Loss of drilling fluid to fractures during drilling process
  - High cost of drilling fluid
  - Potential damage to injection formation
- Loss of stimulation fluid to initial fractures opened during hydraulic stimulation of EGS formation
  - Unable to open up new fracture system

Relevance/Impact of Research

The commercial success of EGS requires:

Injection formation be drilling with fluids that allow adequate hole cleaning and minimize the losses. The volumes of fluid losses can be excessive that the financial impact could be excessive. These losses must be controlled during drilling

That large surface areas of reservoir formation are accessible to injected fluids so that hear transfer from the formation can be maximized. Without the ability to perform multiple fracturing treatments the commercial success will be limited.

If successful the development of these diverter created fracture systems could multiply the amount of produced steam from said EGS wells

Scientific/Technical Approach

Focus on developing materials that:

- Seal on the fracture face with only moderate leakage of fluid past materials during drilling and fracturing
- Combination of particle sizes and sealing efficiencies (plastic deformation) to seal for the duration of time required but also maintain seal at the temperature seen in these applications
- Materials must degrade at the appropriate time at elevated temperature without leaving any damage to the fractures in the injection formation

Accomplishments, Expected Outcomes and Progress

- Expected outcomes:
- Identification of the candidate materials
- Test sealing of various materials in specially developed laboratory equipment
  - Static slot tester
    - Measure diversion efficiencies for different fracture apertures
    - Develop empirical correlations of PSD and Diversion Efficiency
  - Dynamic Flow Diversion Reactor
    - Dynamic measure of deposition and sealing efficiencies

Expected outcomes continued:

LCM and Diverter durability and degradation kinetics under static condition

- Long term degradation tests in static conditions submerged in water
- Long term degradation tests in simulated fracture scenario under differential pressure and application temperature
- Focus will be on degrading but also potential damage to the fracture network

Project Management/Coordination

The project is divided by the following:

CSI will perform screening, develop correlations, perform long term studies on sealing and degradation kinetics

EGI (U of U) will design lab-scale dynamic apparatus and conduct tests to confirm initial static tests

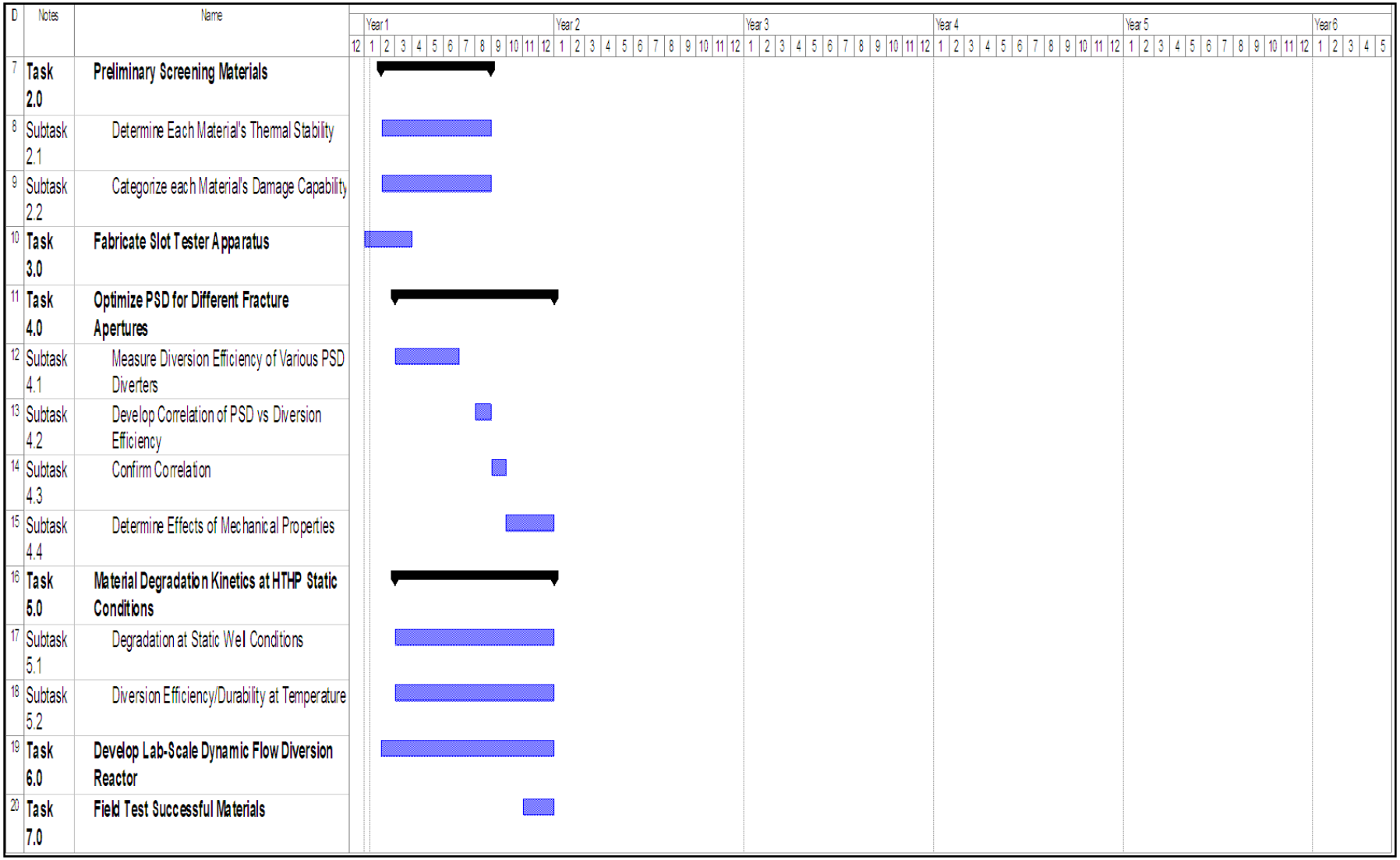
AltaRock will implement viable material candidates in field applications

Project Management/Coordination

ID	Notes	Name	Total Cost
1	**Phase 1**	**Material Identification, Initial Laboratory and Field Studies**	
2	Task 1.0	Identification of Candidate Materials or Processes	$50,973.74
3	Task 2.0	Preliminary Screening Materials	$203,797.26
4	Task 3.0	Fabricate Slot Tester Apparatus	$101,796.01
5	Task 4.0	Optimize PSD for Different Fracture Apertures	$110,283.66
6	Task 5.0	Material Degradation Kinetics at HTHP Static Conditions	$192,573.22
7	Task 6.0	Develop Lab-Scale Dynamic Flow Diversion Reactor	$231,421.99
8	Task 7.0	Field Test Successful Materials	$460,751.67
9	**Project Total**		**$1,351,597.55**

Project Management/Coordination

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Future Directions

Future plans for project:

- Determine new materials for potential application
- Test materials as to set performance characteristics
- Select materials to go to next level of testing
- Develop correlations to predict seal and durability in real well scenario
- Get materials made in large enough quantities to conduct field job
- Use material in real well scenario

Summary

- Project to investigate sealing materials for both Drilling and Fracturing in EGS wells underway
- Potential materials being evaluated as we speak
- Most of project still left to be performed
- Preliminary results have identified several new materials that meet the criteria for application
- Many companies are interested in this work and CSI has been contacted by many manufacturer to supply materials to test