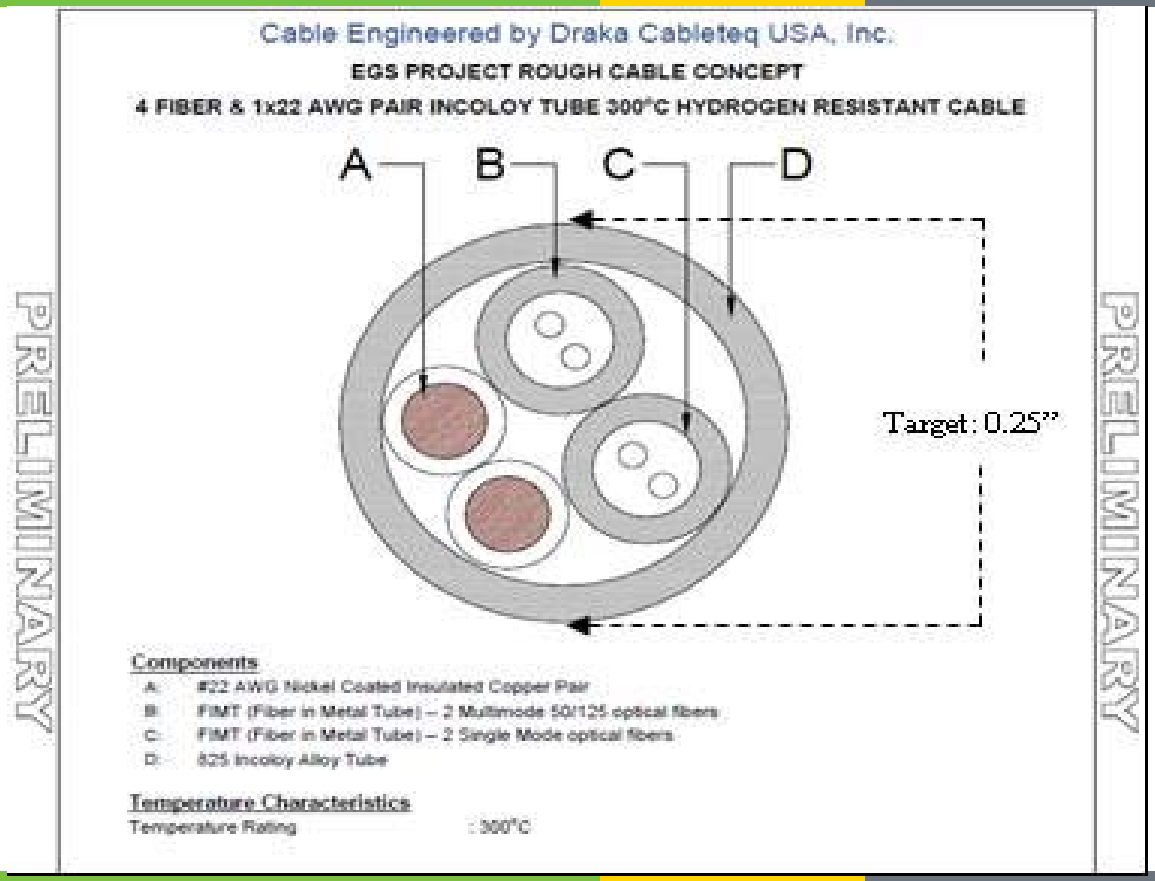

Complete Fiber/Copper Cable Solution for Long-Term Temperature and Pressure Measurement in Supercritical Reservoirs and EGS Wells

May xx, 2010

Principal Investigator
Dr. Mark Lowell
Draka Cableteq USA

Track Name

Overview

- **Timeline**
  - January 2010 to October 2012 / 2 % complete
- **Budget**
  - Total project funding: $ 4,224,391
  - DOE share: $ 3,222,398 86.3 %
  - Awardee share: $ 1,001,993 23.7 %
  - Funding received: None
- **Barriers**
  - Hydrogen resistant optical fibers
  - High temperature (> 300 deg. C) optical fiber coating
  - High temperature (> 300 deg. C) cable materials
- **Partners**

Draka Communications Sandia Labs SensorTran

Tetramer Technologies PermaWorks Omnisens

AltraRock

Objectives

1. Optical fibers that resist hydrogen “darkening” for several months instead of hours and days at 300 deg. C and higher
2. Tube encapsulated cable (TEC) construction that functions as a distributed temperature sensor (DTS) and a power source for a downhole pressure sensor
3. Demonstration of temperature and pressure monitoring in a geothermal well
4. Evaluate fiber sensors with both Raman and Brillouin DTS instruments

Potential Benefits

- Reliable distributed temperature sensor
- More accurate monitoring of well conditions: temperature and pressure
- Higher well productivity
- Other applications: oil and gas wells

Innovative aspects

- Finely controlled optical fiber chemistry
- Unique fiber coating chemistry
- Fiber in metal tube process technology
- Tube encapsulated cable technology

Project Organization – Technical

- Phase 1 – Optical Fiber Development
- Phase 2 – Cable Development
- Phase 3 – Cable Testing and Validation

Phase 1 Tasks and Deliverables

- Task 1 – Fiber Development
  - Hydrogen-insensitive fibers laboratory testing
  - Hydrogen-insensitive fibers with a high temperature coating for geothermal down-hole testing
- Task 2 – Coatings Development
  - Design and synthesis of novel high-temperature polymers.
- Task 3 – Fiber Testing and Validation
  - Validate hydrogen resistance of the optical fibers

Phase 2 Tasks and Deliverables

- Task – High Temperature Fiber in Metal Tube (FIMT)
  - Optimized FIMT construction and manufacturing process
- Task 2 – High Temperature Cable Development
  - Produce four trial lengths of 22 AWG twisted pair cable
  - Validate that this cable can conduct 30mA.
- Task 3 –Tube Encapsulated Cable (TEC) Development
  - Confirmation of final design and process capabilities
  - Two or more cable prototypes for well deployment

Phase 3 Tasks and Deliverables

- Task 1 – Short Term Downhole Tests
  14 days
- Task 2 – Medium Term Downhole Tests
  41 days (1000 hours)
- Task 3 – Long Term Tests
  12 months

Qualifications -- Draka

- Draka Cableteq USA
  - Downhole cable specialist
  - Welded metal tube cable manufacturer
  - Fiber sensor testing lab
- Draka Communications
  - Optical fiber specialist
  - Optical fiber manufacturer
  - FIMT manufacturer

Qualifications -- Partners

- Tetramer Technologies: high temp. polymers specialist
- Sandia Labs: hydrogen testing of fibers
- SensorTran: supplier of Raman type DTS instrument
- Omnisens: supplier of Brillouin type DTS instrument
- PermaWorks: supplier of downhole tool
- AltraRock: geothermal well operator

Accomplishments

new project, just started work

Planned accomplishments/outcomes

- A reliable downhole temperature and pressure monitoring tool
- Determination of the maximum operating range above 300 deg. C using new techniques developed
- A clear understanding of the technical issues and recommendations for further work

Project Management Plan

- Project Teams by Phase
  - Microsoft Project plans created for each Draka participant
- Project Website
  - Project dashboard
  - Store project plans and updates
  - Store technical reports
  - Store expense records
- Spend Management
  - Budget detailed by tasks and by expense type
  - Templates used to collect and consolidate expenses

Project Dashboard

Last updated: April 21, 2010	Due Date	% Complete	Time Behind	Status
Phase 1: Development of High Temp Fiber	Oct 27, 2011	5%	--	
Task 1: Fiber Development	May 6, 2011	10%	--	
Task 2: Coating Development	Jan 17, 2011	5%	--	
Task 3: Fiber Testing and Validation	Oct 27, 2011	0%	--	
Phase 2: Cable Development	Aug 15, 2011*	3%	--	
Task 1: FIMT Development	Aug 15, 2011*	0%	--	
Task 2: High Temp Cable Development	Oct 7, 2010	10%	--	
Task 3: Metalclad Cable Development	Apr 4, 2011*	0%	--	
Phase 3: Cable Testing and Validation	--	0%	--	

In Progress Behind Schedule Critically Behind Schedule Not Started

*Date represents the end of development and testing related to Phase/Task. Production and testing of final product with optimized fibers will go beyond these dates.

Schedule

Months	Activities	Budget
1 to 6	Preliminary fiber & cable development	$ 1,824,333
7 to 12	Advanced fiber & cable development	$ 1,361,574
13 to 34	Final cable development & downhole trials	$ 1,038,485

Upcoming Milestones

- Test plan for hydrogen testing at Sandia Labs
- Fiber prototypes for hydrogen testing
- Fiber draw trials with initial samples from Tetramer Tech.

Summary

Talented technical team

- Specialty fiber optics development, testing, and production
- Downhole cable and tool development and production
- Geothermal well operation and monitoring.

Thorough Project Management Plan

Important Well Productivity Tool

The improved temperature and pressure monitoring will allow more productive geothermal well performance.