SPE UNIVERSITY OF UTAH STUDENT CHAPTER

Volume 1 / Issue 3

UPCOMING EVENTS

Rocky Mountain Student Symposium
Date: February 26-27
Place: Montana Tech

AAPG Lecture by Dr. Alan Carroll, *"What Everyone Should Know About Fossil Fuels"*
Time: March 3, 4-5 PM
Place: James Talmage Bldg. (JTB) Room 310

A BOREHOLE FLOWMETER FOR MEASURING FLOW PROFILES IN GEOTHERMAL AND PETROLEUM WELLBORES

Biographical Sketch

Peter Rose, Ph.D., Energy & Geoscience Institute at the University of Utah; Research Professor, Department of Civil and Environmental Engineering

Peter Rose obtained an M.S. in Chemistry and a Ph.D. in Chemical Engineering at the University of Utah and was a rocket scientist at Thiokol Corporation in the mid-1980s. In the latter position, he helped develop new methods and materials for the fabrication and demonstration of carbon/epoxy solid-rocket-motor cases. As a Research Professor for the past 21 years at the Energy & Geoscience Institute at the University of Utah, Dr. Rose has developed novel tracers and tracer-testing techniques for geothermal, environmental, and petroleum applications. In this capacity, he has demonstrated families of tracers, including the naphthalene sulfonates and the short-chain aliphatic alcohols that have achieved worldwide application as tracers in liquid-phase and vapor-phase geothermal reservoirs, respectively. He has recently focused on the development of reversibly-adsorbing, reactive tracers that, in combination with conservative tracers and appropriately calibrated flow-simulation models, can be used to constrain the tracer-contacted fracture surface areas—for geothermal and shale-gas applications. As President of FluidTracer, Inc., Dr. Rose was recently awarded a Small Business Innovation Research (SBIR) to design and develop a novel tracer-based flowmeter for measuring flow in geothermal and petroleum-waterflood wellbores.

Upcoming Event: **Career opportunities in Petroleum Industry for Engineering Students - by A Panel of Renowned Professors and Professionals in Mechanical, Computer, Civil, Geological and Chemical Engineering.**

Time: March 10th, 4-5 PM, *Place*: WEBL110, Please RSVP to universityofutah@spemail.org

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A Borehole Fluorimeter/Flowmeter for Measuring Flow Profiles in Injection and Production Wells

Wellbore-flow profiling is important to both the petroleum and geothermal industries, since it allows operators to determine from which zones fluids are produced in a borehole or into which zones fluids are injected. Such knowledge can inform reservoir managers on decisions about when and how to workover or abandon problematic wells. Under an SBIR grant, FluidTracer, Inc. has designed and is in the final stages of fabricating a borehole tool to measure flow within a high temperature/high pressure geothermal wellbore. The design team has started testing the tool in the laboratory with the objective of demonstrating it in early 2016 in a flowing geothermal well. See Figure 1 for a sketch of the tool in its production-flow-profiling mode.

This flow-measurement tool is based upon a well-established tracer-dilution method that has become the standard for accurately measuring single- and two-phase flow in surface pipes. In applying the tracer-dilution method to our application, the tracer is injected at one end of the tool at a constant concentration and flow rate using a syringe pump. The tracer then mixes evenly within the wellbore as the brine flows up and around the tool to its opposite end where its concentration is measured — after the tracer has been evenly diluted within the wellbore. Based on the following simple governing equation, a calculation is performed using software within the tool to determine the volumetric flow rate (Q_w) of water at discreet depths within the wellbore:

$$Q_w \times C_w = Q_p \times C_p$$

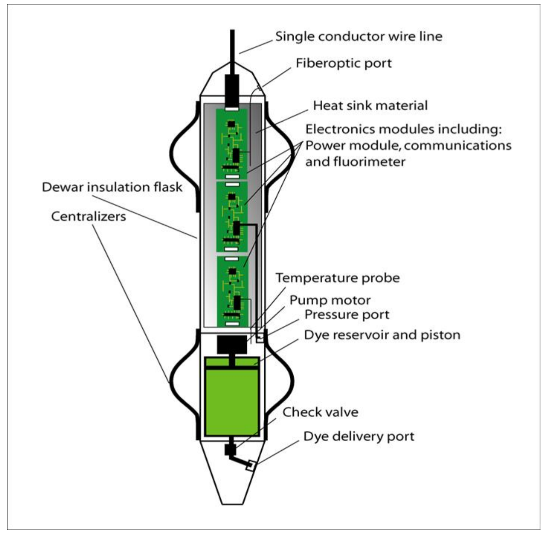

Figure 1. Sketch of FluidTracer's borehole FluorFlow™ tool showing the tracer delivery pump at one end of the tool and the tracer-measuring port at the opposite end.

where C_p is the concentration of the tracer coming from a tracer-delivery pump and into the wellbore, Q_p is the flowrate of that tracer solution from the pump into the wellbore, C_w is the measured concentration of the thoroughly mixed tracer at the upper end of the tool and Q_w is the flow rate of fluid within the wellbore. Both C_p and Q_p are known, C_w is measured, leaving only Q_w to be calculated from the equation. As the tool is made to ascend or descend along the wellbore, the flow is measured as a function of depth and a flow log is created. Figure 2 shows the tool being assembled in EGI's lab.

Figure 2. Photo of FluidTracer's borehole FluorFlow™ tool during assembly in EGI's lab. This portion of the tool shows only the spring-driven syringe pump and the tracer-ejection module. When completely assembled, the tool will measure approximately 18' in length and 2.875" in diameter.

Some of the tool's notable features include

- the use of an environmentally benign and thermally-stable fluorescent tracer (fluorescein) to accurately measure flow rates without the use of error-prone, mechanical-spinner tools;
- a novel spring-driven syringe pump that allows for the accurate delivery of the tracer without the use of an electric pump;
- a Linear Variable Differential Transformer (LVDT) that measures the displacement of the pump's plunger over time—providing a measure of flow rate;
- a Dewar flask that keeps the temperature-sensitive electronics and optics below 1250°C during the operation of the tool at temperatures as hot at 3000°C for 3 hours;
- synchronous detection that matches the photodetector measurements to the pulsing LED light source—allowing for much improved sensitivity; and
- deployment of the tool on either a single-conductor electrical cable (e-line) or a mechanical cable (slickline) to allow for measurements either in real time or in memory mode.

CONTACT US

Siavash Nadimi- Editor-in-Chief: snadimi@egi.utah.edu
Jessica Page- Editor: jessica.page@utah.edu