RUGGED, LONG-LIFE FLOW MONITORING FOR ENHANCED GEOTHERMAL SYSTEMS

A. Matt Francis (PI), Jim Holmes, Matthew Barlow, Nick Chiolino, Ian Getreu – Ozark IC, Inc, Fayetteville, AR
francis@ozarkic.com, holmes@ozarkic.com, barlow@ozarkic.com, chiolino@ozarkic.com, getreu@ozarkic.com
Fredrik Rehnmark, Jameil Bailey, Evan Cloninger – Honeybee Robotics ETG Office, Pasadena, CA
rehnmark@honeybeerobotics.com, bailey@honeybeerobotics.com, cloninger@honeybeerobotics.com
Joshua Mengers (PM), Department of Energy, Geothermal Technologies Office

Introduction
Problem:
➢ How to measure movement of well fluids
➢ The efficacy of a geothermal well is determined by measuring the fluid enthalpy

Proposition:
➢ Using hardened technologies, OzIC and Honeybee will demonstrate the use of a turbine/spinner to measure this flow

Methods
Ozark IC and its partners have developed unique technologies for sensing and actuation for future NASA missions to the Venus surface (up to 500°C and 100 bar) – similar to conditions within enhanced geothermal wells on earth.

Honeybee Robotics has demonstrated brushless DC motors operating at these conditions as the basis of advanced robotics.

Results
➢ Honeybee’s TRL-5 actuator has demonstrated a continuous power production of ~70W at temperature.
➢ Ozark IC has fabricated test structures, devices and application circuits in several fabrication runs and demonstrated the most complex integrated circuits to date operating at 470°C for up to 100 hours.

Conclusions/Future Work
Building on test results at high temperature for both actuation and circuit applications, both OzIC and Honeybee will collaborate to design a flow sensing module.

Summary
The efficacy of geothermal wells depend on the ability to monitor fluid flow. The extreme high temperatures of these fluids require hardened technologies currently not available on the market. OzIC and Honeybee have developed a solution to this need from previous Venus applications. These modules will be utilized to create a flow sensor rugged enough to withstand the high temperatures found in these fluids.

Honeybee motor has been tested at full Venus conditions (CO₂ atmosphere at 500°C and 92 bar of pressure).

Flow sensing module is stackable and may be combined with other modules in any desired configuration. Possibilities include redundant sensors, measurement at multiple depths and a flexible suite of sensors.

Honeybee motor has been tested at full Venus conditions (CO₂ atmosphere at 500°C and 92 bar of pressure).