ABSTRACT

Carbon Dioxide Generation and Top Side Equipment in Support of
Enhanced Oil Recovery -- Enhanced Geothermal Systems, or Both!
Paul M. Dunn (Presenter), COO, Gas Equipment Engineering Corporation (GEECO);
Rick Mobley, CEO, Plasma Energy (PE); Greg Gutoski, Technical Director, Fairbanks Morse Engine (FME);

Geothermal Power and Enhanced Oil Recovery (EOR) have been around for a long time, but next generation Enhanced Geothermal Systems (EGS) and Tertiary EOR, may have at least one thing in common, supercritical CO2. Gas Equipment Engineering Corporation, founded in 1921 as a producer of CO2, has teamed with Plasma Energy, Fairbanks Morse Engine, and many others in several efforts which pursue the common need of low cost CO2 and new lower or zero emission power generating technology.

The synergistic strengths of GEECO, PE, and FME are briefly reviewed as an introduction, and paper reviews the benefit of CO2 over water for EGS and EOR. Simple models have indicated gains in power generation / efficiency of 58% to 181% depending on approach and details of the geology, for EGS-CO2 over conventional EGS. EOR yield varies widely from site to site, but similar or greater gains in delivered product can occur with supercritical CO2 (Tertiary EOR) vs. conventional water based Secondary EOR.

The paper establishes the “cost barrier” for CO2 based systems, and then proposes several ways to remove this barrier. In areas where CO2 is not naturally occurring (or available in a pipeline), the cost of trucked in CO2 at up to $300 / ton is a substantial deterrent to EGS-CO2 or Tertiary EOR. Traditionally CO2 is manufactured / captured in flue gas via chemical adsorbtion; MEA was used in the early GEECO CO2 generators.

The paper then discusses two system alternatives which both generate nearly pure CO2 at pressure for EGS / EOR, and which also generate power. Depending on the fuel source and local electric rate, the cost of CO2 is reduced by at least a factor of 4, and in certain scenarios becomes cost neutral or revenue generating. In both systems, a cryogenic Air Separation Unit or a Vacuum Pressure Swing Adsorber is used to generate nearly nitrogen free oxygen. In areas where refined fuels at low cost are available (preferably natural gas), a closed cycle diesel approach is used, with a medium speed FME Dual Fuel (CNG / Diesel) engine and generator set as the core of the process. The engine is fed by a GEECO VPSA Oxygen Plant, and operates on a semi-closed cycle with CO2 (exhaust gas recirculation), and is “combined heat and power” configured. In areas where refined fuels are not available, and also in areas where greater gain is possible via integration with other oil field processes a novel PE combustor is used. Operating with nearly pure oxygen from a GEECO cryogenic Air Separation Unit, the PE combustor is capable of burning unrefined / waste fuel sources, including PET Coke and other very high sulfur fuels. As a result of the very high temperatures and unique cycle, normally undesirable sulfur / metal containing combustion products are captured as useful particulates and while recirculating CO2 is used as a diluent in the subsequent power producing process (rankine / kalina). In both cases, Plasma Energy Combustor or FME Closed Cycle Diesel, the system “exhaust” is CO2, Water, and very little Nitrogen, which are easily separated. Compression is provided by GEECO and CO2 is available for EGS or EOR at 1000 to 3500 psig. There are no green house gas emissions with either approach (assuming the CO2 is used for those purposes).

Finally, the paper reviews future plans. Gains are possible via greater integration with oil field processes, integration of EGS and EOR, and alternative cycles / machinery. GEECO and our partners are dedicated to new solutions to the Nation’s current and future energy crisis that have substantial environmental and cost benefit.