Gulf Coast Association of Geological Societies and Gulf Coast Section SEPM

TRANSACTIONS
56th ANNUAL CONVENTION
LAFAYETTE, LOUISIANA
SEPTEMBER 25-27, 2006

Hosted by the Lafayette Geological Society
EXTENDED ABSTRACT

The geopressed-geothermal resource consists of gas-saturated brines contained in sandstone reservoirs under higher than normal confining pressure and temperature. Such reservoirs are present in several sedimentary basins worldwide and those in the United States are shown in Figure 1. The northern Gulf of Mexico is the largest of such basins in the United States and is also one of the best known due mainly to the intensive exploration and production activities in this area. The northern Gulf of Mexico geopressed-geothermal resource has been estimated by Dorfman (1988) to contain approximately 250 TCF (trillion cubic ft) of recoverable natural gas and other researchers have provided various estimates ranging from 150 to 5,000 TCF and up to 11,000 quads of thermal energy in sandstone pore fluids to a depth of 22,500 ft. These estimates are all equivalent to many times more than the presently known conventional methane resources in the United States. The geopressed-geothermal resource contains chemical energy in the form of methane dissolved in pressurized brine, thermal energy consisting of high temperature brines (250°F) which could be used for secondary hydrocarbon recovery and/or electricity generation, and mechanical energy generated through high brine flow rates (20,000+ barrels per day) which could be utilized to drive turbines to generate electricity.

The U.S. Department of Energy conducted a geopressed-geothermal research program in the northern Gulf Coast to gather reliable geological engineering, environmental and economic information about this resource to determine its viability for development from 1975 to 1992. A comprehensive summary of the research program is provided in John et al. (1998). The research program involved industry, universities and national laboratories. The locations of all wells selected for testing are shown in Figure 2. Of these, four were drilled and tested (Nos. 7, 8, 9, and 15 shown in Figure 2) while all the others were donated by the oil and gas industry for testing. The Lafourche Crossing well location was originally selected but the well was not drilled. Some of the other wells (Nos. 10, 11, and 16 shown in Figure 2) were abandoned before testing due to well problems. Summary results of wells successfully tested are shown in Table 1. The Gladys McCall well located in Cameron Parish, Louisiana was tested for the longest period of time (4 yrs). Though eleven potential production zones were identified, only...
two zones were flow tested. During the test period the well produced over 27 million barrels of brine and 676 million SCF (standard cubic ft) of gas from the brine. Testing of Pleasant Bayou #2 well in Brazoria County, Texas, was significant in that a direct use application of the geopressed-geothermal resource was successfully demonstrated by the generation of electricity using a hybrid power electrical generation system which utilized the geothermal energy of heat and gas from the well fluids.

Plum et al. (1989) conducted an economic study of the geopressed-geothermal resource using characteristics of geopressed-geothermal brines found in the northern Gulf of Mexico. A computer model calculated breakeven prices necessary to market natural gas and electricity. The breakeven price was defined as the minimum per unit price for the developer to recover all direct and indirect costs plus a rate of return sufficient to compensate depreciation, the time value of money, and risk of failure. For a Gladys McCall-type production well with a constant flow rate of 25,000 barrels per day for 10 years, assuming all natural gas is sold and only the thermal energy is used to produce electricity, the breakeven prices calculated by Plum et al. (1989) were $7.70/MCF (thousand cubic ft) and $0.23/kWh (kilowatt-hrs) (1990 dollars). Inflated to 2005 dollars, the breakeven prices are $11.51/MCF and $0.34/kWh. (This inflation may not reflect actual cost increases in the oil & gas industry.) Major assumptions are: 1) a Gulf Coast oil or gas well can be taken over before its abandonment and converted into a geopressed-geothermal production well, 2) drilling of a shallow injection well, 3) a development and construction period of 18 months, and 4) a 15% discount rate. Using a different scenario of producing electricity from all energy resources (natural gas, heat, and hydraulic) yielded a breakeven price of $0.147/kWh (1990 dollars); inflated to 2005 dollars the breakeven price becomes $0.22/kWh. The Pleasant Bayou, Texas, resource characteristics gave similar breakeven prices. Plum et al. (1989) also modeled higher-quality geopressed-geothermal resources, i.e., with higher temperatures and gas content. As could be expected, substantially lower breakeven prices were calculated.

The testing and development of a geopressed-geothermal resource necessitates high volume brine production (>20,000 barrels per day, per well) and the subsurface disposal of brine after gas extraction. The potential environmental issues of relevance

Figure 1. Geopressed basins of the United States (modified after Wallace, 1982).
The Gulf Coast Geopressured-Geothermal Resource

Figure 2. Location of wells selected for testing under the DOE geopressured-geothermal research program (courtesy of U.S. Department of Energy’s Geothermal Program).

under this scenario include potential land surface subsidence, fault activation and/or reactivation, fresh-water aquifer contamination, and accidental brine spills. The geopressured-geothermal research program included monitoring programs designed to evaluate each of these environmental issues which were established prior to, during and after plugging and abandonment of the well. Microseismic monitoring, benchmark surveying, water sampling and analysis and monitoring of all surface activities were conducted. No noticeable or significant long-term detrimental environmental impacts were observed resulting from the well testing.

The program identified geopressured-geothermal fairways in Louisiana and Texas, determined that high brine flow rates (20,000–40,000 barrels per day) are possible for long periods of time without significant reservoir pressure drawdown, found that gas/brine ratio ranged from 24-55 SCF/STB (standard cubic ft of gas per stock-tank barrel) (Table 1) and found that used brine could be reinjected into sands below the freshwater aquifers without contamination. Inhibitors controlled corrosion and scaling, and a hybrid power system generated electricity using both separated methane and geothermal heat. In addition to generating electricity, there are a large number of the other potential applications of this resource as shown in Figure 3 and these other uses have not been tested. Profitable commercial development of this resource at that time was unfavorable. The energy picture today has changed and the gas and oil prices are considerably higher. With predicted worldwide shortages in a world dependent on fossil fuels, the costs are very likely to increase resulting from increasing consumption and demand for these resources. With the prevailing improved technology the development of the geopressured-geothermal resource in combination with its numerous direct and relatively environmentally safe uses will significantly lower the breakeven price for exploitation of this resource and could potentially be part of the answer to the country’s energy problem. It is time for industry to reconsider the commercial viability of this unconventional alternative energy resource.
Table 1. Summary of test results from the geopressed-geothermal wells tested under the DOE program (John et al., 1998).

<table>
<thead>
<tr>
<th>Well Name</th>
<th>Depth (ft)</th>
<th>Pressure (psi)</th>
<th>Temp. (°F)</th>
<th>Salinity (ppm TDS)</th>
<th>Gas/Brine Ratio (SCF/STB)</th>
<th>Flow Rate (BPD)</th>
<th>Methane (mol%)</th>
<th>CO2 (mol%)</th>
<th>Other Gases (mol%)</th>
<th>Porosity (%)</th>
<th>Permeability (mD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delcambre 3sd</td>
<td>12,869</td>
<td>11,012</td>
<td>238</td>
<td>133,300</td>
<td>24.0</td>
<td>10,333</td>
<td>92.8</td>
<td>1.1</td>
<td>6.1</td>
<td>26.0</td>
<td>44.0</td>
</tr>
<tr>
<td>Delcambre 1sd</td>
<td>12,573</td>
<td>10,858</td>
<td>234</td>
<td>113,000</td>
<td>24.0</td>
<td>12,653</td>
<td>95.4</td>
<td>2.0</td>
<td>2.6</td>
<td>29.0</td>
<td>364.0</td>
</tr>
<tr>
<td>F.F. Sutter</td>
<td>15,781</td>
<td>12,220</td>
<td>270</td>
<td>190,904</td>
<td>24.9</td>
<td>7,747</td>
<td>89.6</td>
<td>7.9</td>
<td>2.5</td>
<td>19.3</td>
<td>14.3</td>
</tr>
<tr>
<td>Buealah Simon</td>
<td>14,722</td>
<td>13,015</td>
<td>266</td>
<td>103,925</td>
<td>24.0</td>
<td>11,000</td>
<td>88.9</td>
<td>7.7</td>
<td>3.4</td>
<td>17.4</td>
<td>11.6</td>
</tr>
<tr>
<td>P.R. Giroud</td>
<td>14,744</td>
<td>13,203</td>
<td>274</td>
<td>23,500</td>
<td>44.5</td>
<td>15,000</td>
<td>91.3</td>
<td>6.0</td>
<td>2.7</td>
<td>26.0</td>
<td>220.0</td>
</tr>
<tr>
<td>P. Canal</td>
<td>14,976</td>
<td>12,942</td>
<td>294</td>
<td>43,400</td>
<td>47.0</td>
<td>7,100</td>
<td>88.4</td>
<td>8.4</td>
<td>3.2</td>
<td>22.5</td>
<td>90.0</td>
</tr>
<tr>
<td>C. Zellerbach</td>
<td>16,720</td>
<td>10,144</td>
<td>330</td>
<td>31,700</td>
<td>55.7</td>
<td>3,887</td>
<td>71.0</td>
<td>23.5</td>
<td>5.5</td>
<td>17.0</td>
<td>14.1</td>
</tr>
<tr>
<td>Amoco Fee-Sweet Lake A</td>
<td>15,387</td>
<td>11,974</td>
<td>298</td>
<td>160,000</td>
<td>34.0</td>
<td>34,000</td>
<td>88.7</td>
<td>8.6</td>
<td>2.6</td>
<td>20.0</td>
<td>400.0</td>
</tr>
<tr>
<td>Parcperdue - L.R. Sweezy No. 1</td>
<td>13,395</td>
<td>11,410</td>
<td>237</td>
<td>99,700</td>
<td>30.0</td>
<td>10,000</td>
<td>94.0</td>
<td>2.5</td>
<td>3.5</td>
<td>29.4</td>
<td>500.0</td>
</tr>
<tr>
<td>Gladys McCall A</td>
<td>15,508</td>
<td>12,936</td>
<td>298</td>
<td>95,500</td>
<td>30.4</td>
<td>36,500</td>
<td>88.9</td>
<td>9.5</td>
<td>3.6</td>
<td>24.0</td>
<td>90.0</td>
</tr>
<tr>
<td>Gladys McCall B</td>
<td>15,158</td>
<td>12,821</td>
<td>288</td>
<td>94,000</td>
<td>30.4</td>
<td>36,000</td>
<td>85.9</td>
<td>10.6</td>
<td>3.5</td>
<td>22.0</td>
<td>130.0</td>
</tr>
<tr>
<td>Pleasant Bayou Well No. 2</td>
<td>16,465</td>
<td>9,800</td>
<td>302</td>
<td>127,000</td>
<td>24.0</td>
<td>25,000</td>
<td>85.0</td>
<td>10.0</td>
<td>5.0</td>
<td>19.0</td>
<td>200.0</td>
</tr>
<tr>
<td>Hulin No. 1</td>
<td>21,546</td>
<td>18,500</td>
<td>360</td>
<td>195,000</td>
<td>34.0</td>
<td>15,000</td>
<td>93.0</td>
<td>4.0</td>
<td>3.0</td>
<td>13.0</td>
<td>13.0</td>
</tr>
<tr>
<td>Riddle Saldana No. 2</td>
<td>9,745</td>
<td>6,627</td>
<td>300</td>
<td>12,800</td>
<td>41.0</td>
<td>1,950</td>
<td>75.0</td>
<td>21.4</td>
<td>3.75</td>
<td>20.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Lear Koelemay No. 1</td>
<td>11,590</td>
<td>9,450</td>
<td>260</td>
<td>15,000</td>
<td>35.0</td>
<td>3,200</td>
<td>81.4</td>
<td>13.4</td>
<td>5.2</td>
<td>26.0</td>
<td>85.0</td>
</tr>
<tr>
<td>Ross Drait No. 1</td>
<td>12,750</td>
<td>10,986</td>
<td>263</td>
<td>23,000</td>
<td>45.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>23.0</td>
<td>39.0</td>
</tr>
</tbody>
</table>
REFERENCES CITED


Figure 3. Potential applications of the geopressed-geothermal resource (modified after Negus-deWys and Dorfman, 1990).