HYDROTHERMAL ENERGY: A SOURCE OF ENERGY FOR ALCOHOL PRODUCTION

I. Summary

Hydrothermal energy is an appropriate form of energy for alcohol production:

1. It is a technically feasible method to convert a non-portable source of energy into a portable form using commercially available technology.

2. A large amount of hydrothermal energy is available in a temperature range suitable for alcohol production.

3. Alcohol production with hydrothermal energy is cost and energy efficient.

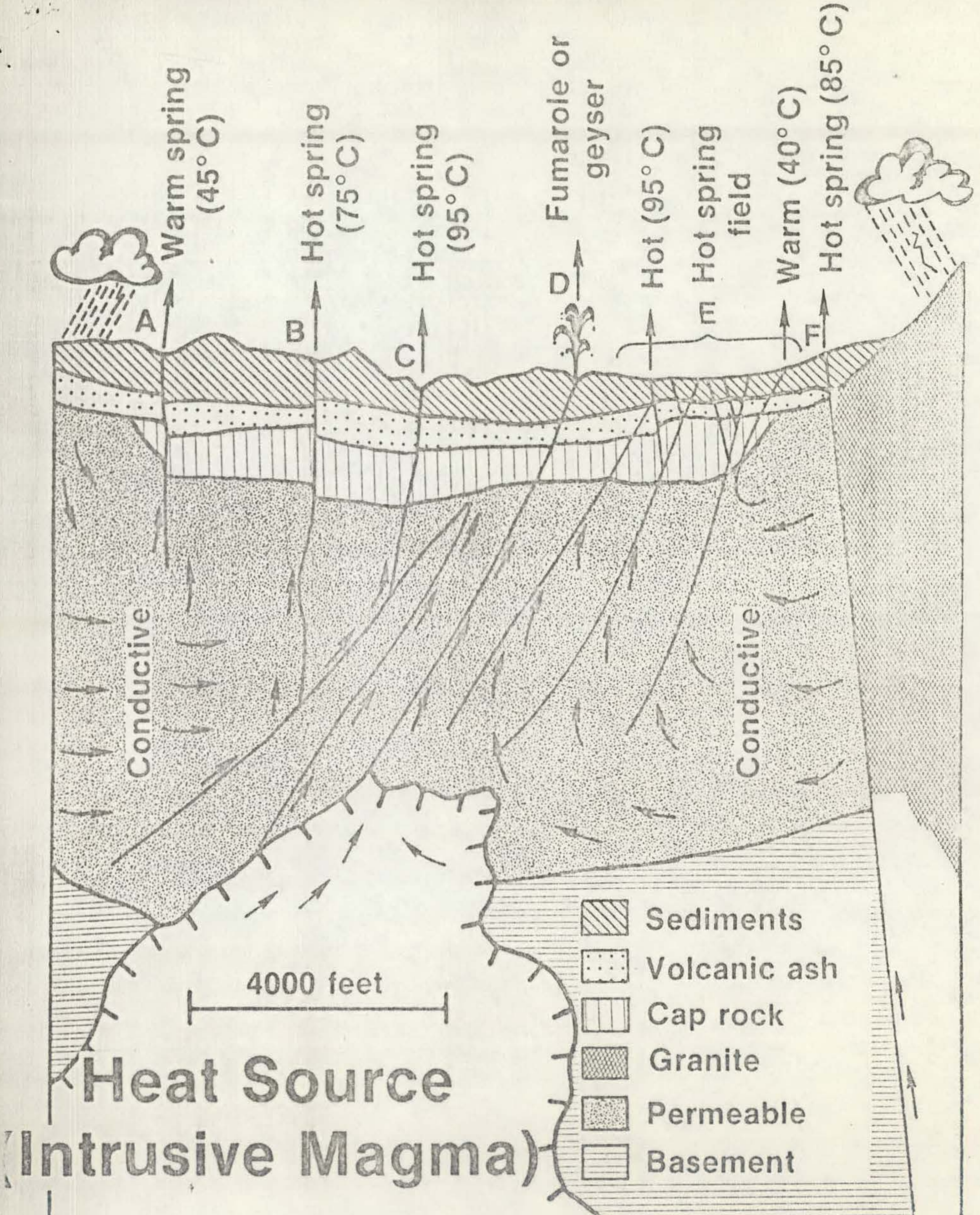
II. Background

The term "hydrothermal energy," as used in this presentation, is hot water that results naturally when meteoric water is heated conductively by an intrusive magma heat source (Figure 1). In most cases, meteoric water flows through a series of fractures and is heated by conduction. These systems, unlike reservoirs of oil, are renewable. For the purpose of this presentation, however, hydrothermal energy is treated as a single lump of energy. Specifically, the USGS estimate of 9600×10^{18} joules is used.

III. Technical Feasibility

Producing alcohol using hydrothermal energy is a technically feasible method of converting a stationary energy source to a portable energy source. The portability change is important, since the major known hydrothermal resources are in the West in areas of relatively low population density.

About mid-summer 1979, DOE and EG&G Idaho, Inc., built a small scale (1 gal/hr) biomass-to-alcohol still at the Raft River Geothermal Site to investigate difficulties in geothermal assisted biomass conversion.



INTRUSIVE MAGMA HEAT SOURCE

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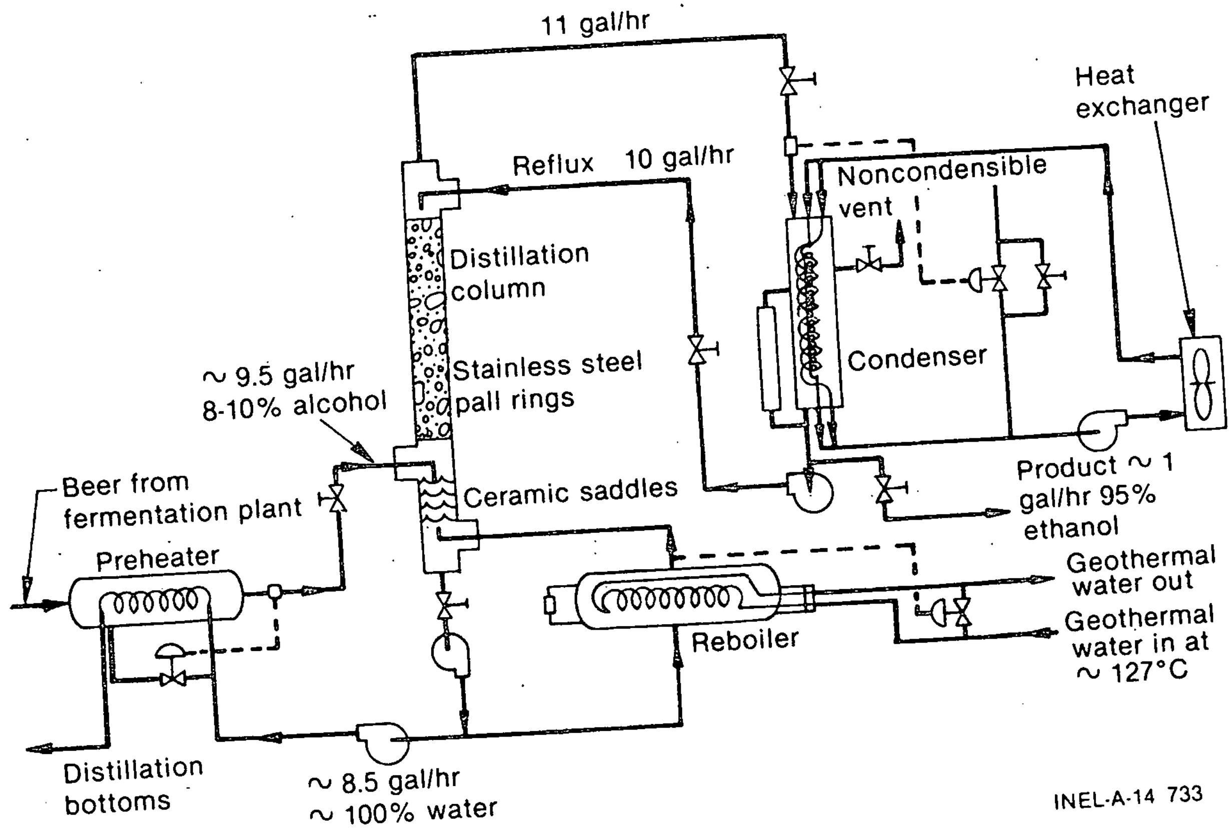
Figure 1

The unit, Figure 2, was successfully operated by the end of August, producing 95% (190 proof) ethanol from sugar beet juice. The unit was designed and built in less than eight weeks from surplus equipment using comercially available design information. This small-scale still demonstrated that 95% ethanol can be produced from sugar beet beer containing 8 to 10% alcohol using geothermal energy and present commercial technology. The geothermal resource provided both an energy source and process water.

Recently, Bechtel National, Incorporated, of San Francisco, California completed a study to analyze the economic feasibility of producing ethanol from potatoes, wheat, and sugar beets using geothermal resources available in the Raft River Region of Idaho. The study concluded that a 20 million gallon per year facility can be built that will supply alcohol at $1.78 per gallon using geothermal energy. A discussion of this plant's economics will be presented later, but at this point it is worthy to note that the technology required to complete this design study is readily available.

Availability of Hydrothermal Energy

The U. S. Geological Survey, in cooperations with the Department of Energy, has published an "Assessment of Geothermal Resources of the United States as of 1978," Geological Survey Circular 790, edited by L. S. Muffer. Calculations based on the estimates of geothermal energy available in the range 212 to 360°F, given in G.S. Circular 790, indicate that there are 4.89×10^{18} to 3.56×10^{18} Btu's of energy that would be of a suitable temperature to produce alcohol (Table 1). Assuming, as the USGS does, that 25% of this energy can be extracted, and that 50% of it is in a location that is suitable for an ethanol plant, there are 0.5×10^{18} Btu available to produce ethanol. If this energy is used in a process that is



SMALL SCALE ALCOHOL SCHEMATIC

Figure 2

Table 1

AVAILABILITY OF HYDROTHERMAL ENERGY

1.	Energy: 212 to 360°F	5.87 - 4.27 x 10^{18} Btu
2.	Wellhead Energy Assuming 25% Recovery	1.27 x 10^{18} Btu
3.	Assume 50% of Energy is Appropriate Placement	0.6 x 10^{18} Btu
	Assume 50% Efficient System	0.3 x 10^{18} Btu
4.	Equivalent Ethanol	3.5 x 10^{12} Gal
5.	10% of U.S. Gasoline Consumption	10.9 x 10^{9} Gal/yr
6.	Number of Years Supply	325 Yr

used in a process that is 50% efficient, geothermal energy has the potential of producing enough alcohol to provide a 10% mixture with gasoline for 275 years.

Efficiency

The Bechtel study, discussed earlier, investigated the feasibility of building a 20 million gallon per year ethanol plant at Raft River. The study considered three different feedstocks: potatoes, sugar beets and wheat. The process energy of the three feedstocks calculated for the Bechtel design are shown in Table 2.

Table 2

PROCESS ENERGY OF THREE FEEDSTOCKS, BTU/GAL

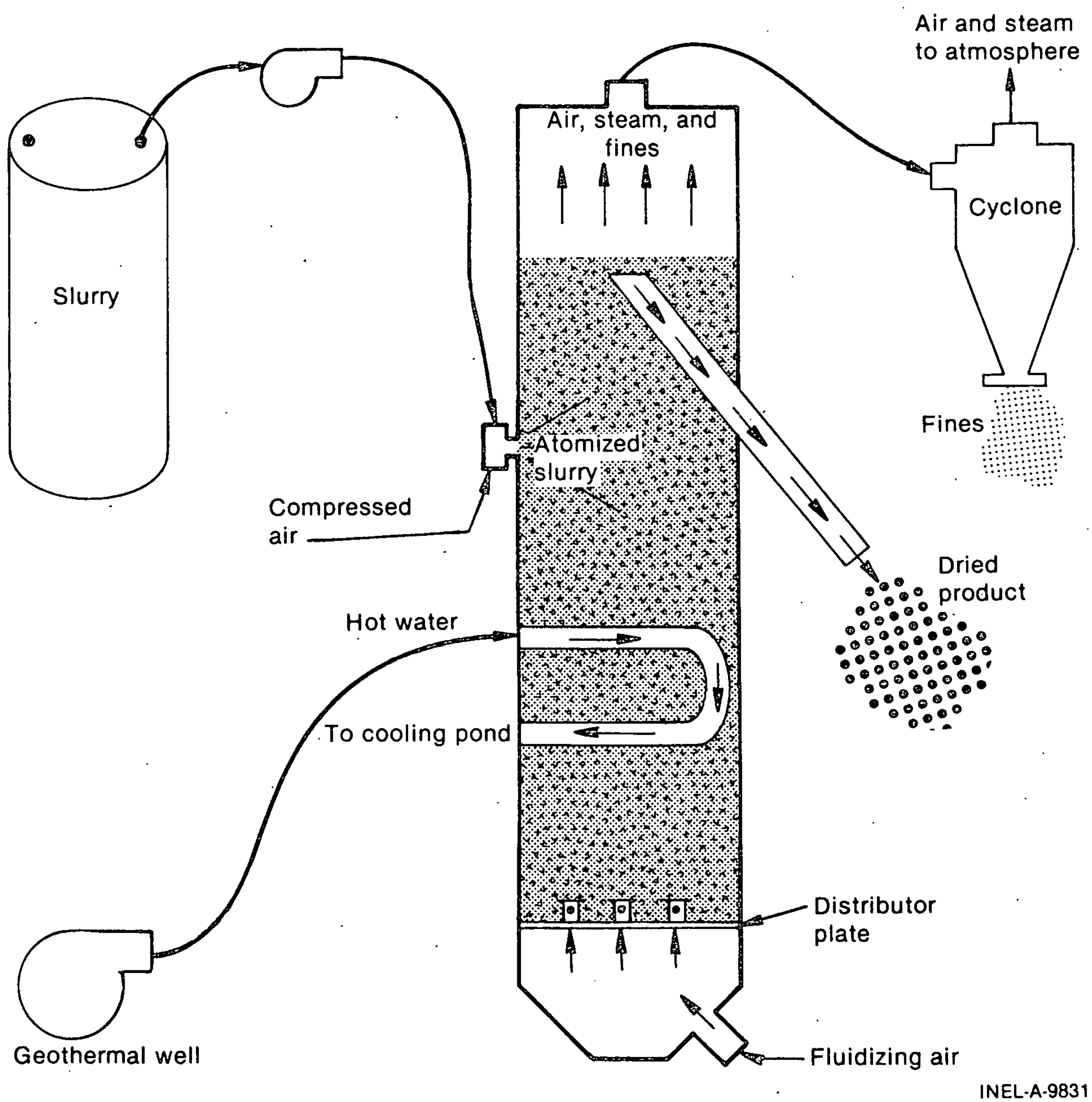
Beets	Potatoes	Wheat
81,180	51,250	54,030

These energies are only the energy required for the distillation process and the geothermal pumping energy and does not include energy required to grow the crops. The overall energy, efficiency for sugar beets would be about 50%, which is much better than what is normally accepted for the production of electricity. Potatoes and wheat are estimated to have total process efficiency of about 65%. These efficiencies are well within an acceptable range when using geothermal energy as a basis.

Disposal of the distillers dried grain (DDG) for wheat/corn feedstock strongly affects the economics and energy efficiency of the process. Drying is a very energy intensive step, and if the DDG is not to be used as feed immediately, the grain must be dried. Hydrothermal energy can be used to alleviate this problem. For example, the Department of Energy tested geothermally powered fluidized bed dryer during 1978 and 1979 at the Raft River Geothermal Test Site. Tests on potato waste material showed that geothermally dried material exhibit a high protein content (Table 3). The dryer used for this experiment (Figure 3) uses an air-fluidized bed and a geothermal fluid for a heat source. As the product dries it rises in the fluidized bed and is allowed to discharge. Fines carried in the air stream are removed in a cyclone The runs made on this small unit indicate that material with the value of DDG can be dried economically in this type of unit.

Conclusion

Production of ethanol with hydrogeothermal energy is appropriate, energy efficient, and economical.



FLUIDIZED BED FRYER SCHEMATIC

Figure 3

TABLE 3

BIOANALYSIS

	Biomass		Caustic Dry Peel		Steam Peel	
	Wet Slurry	Dried Product	Wet Slurry	Dried Product	Wet Slurry	Dried Product
Crude Protein, %	1.7	44.9	1.7	11.9	1.9	5.1[c]
Total N, %	0.26	7.19	0.27	1.91	0.3	0.81
Crude Fat, %	0	0.6	0	0	0.1	0.4
Crude Fiber, %	0.2	2.7	0.8	5.0	0.7	1.1
Ash, %	0.3	25.0	2.2	26.0	0.8	71.0[b]
Nitrogen Free Extract (NFE) %	3.4	24.1	9.4	56.0	12.7	20.9
Total Digestible Nutrient (TDN), %			10.1	59.2	13.3	23.3
Dry Matter, %[a]	5.6	97.4	14.1	98.9	16.2	98.5
Moisture, %	94.4	2.6	85.9	1.1	83.8	1.5

Totals may not add to 100% without complete analysis

a. Dried material is hydroscopic, therefore some moisture increase is possible.

b. Analysis made early after start-up and therefore having higher ash content.

c. May be low due to high ash content after test start up.

CONF- 800526--1

Work supported by the U. S. Department of Energy Assistant Secretary for DOE/Department of Geothermal Energy, Under DOE Contract No. DE-AC07-76ID01570