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GEOTHERMAL ENERGY MARKET POTENTIAL IN INDUSTRIAL PROCESSING

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ABSTRACT

Geothermal energy is currently being used for a number of industrial processes in countries throughout the world. Its application in the United States is mainly limited to space heating even though the temperature of the geothermal fluid is sufficient for process uses, and could be sold at attractive prices while maintaining a high return on investment. The temperature span for industrial use ranges from 40°C to 275°C, thus encompassing both the abundant low temperature and the less available high temperature resources. Hydrothermal fluids can be used either directly or indirectly dependent upon fluid quality and process needs. The barriers facing hydrothermal industrial process development are (a) the development infrastructure does not exist, (b) energy users are not aware of hydrothermal energy and its advantages, (c) federal incentives are limited, (d) resources are not fully defined.

Historical Background

Unlike many envisioned energy systems, direct applications of geothermal energy for process heat is not dependent upon technological breakthroughs. Hydrothermal energy is a viable energy source today with potential for use and expansion into many industries. The earliest utilization of geothermal energy in industrial processing is not well documented, but appears to have been initiated in the early 1950's. A compilation of the types of processes and the country in which they are currently utilized are presented in Table I. The use of hydrothermal resources for industrial processing in the United States is just now becoming viable. The first of these operations are Medo-Bel Creamery in Kalamath Falls, Oregon. Medo-Bel has been using this energy source since 1973 for milk pasturization. Geothermal Food Processors have also recently initiated onion drying operations at Brady Hot Springs, Nevada. The DOE field demonstration program has recently stimulated processing efforts in potato processing, grain drying, aquaculture, agro-processing and sugar processing. It is interesting to note that on a worldwide basis, approximately 5500 MW(th) of geothermal energy is being utilized for direct applications while the current United States use is less than 50 MW(th).

Potential For Process Applications

Industrial energy use represents 40 percent of our national energy budget. The energy used by industry can be broken into the following use categories:[2]

Process Steam	40.6%
Electric Drive	19.2%
Electrolytic Process	2.8%
Direct Process Heat	27.8%
Feed Stocks and Chemicals	8.8%
Other	0.8%

Process steam and direct process heat account for 68.4 percent of the total industrial use of energy much of which potentially can be supplied by hydrothermal energy. Today, high temperature processing is being practiced in many cases only because of the natural temperatures acquired when burning fossil fuels. Current process temperature restrictions must be reviewed in many processes to define the actual process needs.

A study by Intertechnology Corporation[2] reviewed in excess of 75 processes and defined the associated heat requirements. Typical processes, which can be operated in the low- to moderate-temperature range together with the percentage of the process energy needs as a function of maximum temperature required, are given in Table II. It should be noted that the methodology of the study, considered the process temperature required, not the temperature supplied. However, in many processes, time and temperature can be considered as a trade-off when looking at lower temperature energy sources; thus there are potentially many additional processes which can be adapted to low-temperature energy sources.

Analysis of current energy use within the Rocky Mountain Basin & Range region indicates that a prime market sector exists for the direct use of geothermal energy in space conditioning, and in low-to-moderate temperature industrial processing. Currently, greater than 75% of these market sections are being served by fossil fuels, with electricity claiming the majority of the remaining sales. Energy competition projections for the RMB&R region indicate a higher dependence upon

TABLE I
CURRENT INDUSTRIAL PROCESSES USING GEOTHERMAL ENERGY(1)

APPLICATION	COUNTRY	DESCRIPTION OF APPLICATION
Wood & Paper Industry		
Pulp & Paper	New Zealand	Processing and a small amount of electrical power generation. Kraft process used.
Timber Drying	New Zealand	Kiln operation.
Washing & Drying of Wood	Iceland	Steam drying.
Mining		
Diatomaceous Earth Plant	Iceland	Production of dried diatomaceous earth recovered by wet-mining techniques.
Chemicals		
Salt Plant	Japan, Phillipines	Production of salt from sea water.
Sulphur Mining	Japan	Sulfur extraction from the gases issuing from a volcano.
Boric Acid, Ammonium Bicarbonate, Ammonium Sulphate, Sulphur	Italy	Includes recovery of substances from the volatile components which accompany the geothermal steam.
Miscellaneous		
Confectionary Industry	Japan	
Grain Drying	Phillipines	Geothermal steam heats rotary kiln dryer.
Brewing & Distillation	Japan	
Stock Fish Drying	Iceland	Fish drying in shelf dryers.
Curing Cement Build. Slabs	Iceland	Curing of light aggregate cement building slabs.
Seaweed	Iceland	Drying seaweed for export.
Onion Drying	United States	Dehydration of onions.
Milk Pasturization	United States	Milk processing using low temperature resource.

TABLE II
TYPICAL INDUSTRIAL PROCESS HEAT REQUIREMENTS

	40°C-60°C	60°C-80°C	80°C-100°C	100°C-120°C	120°C-140°C	140°C-160°C	160°C-180°C	180°C-200°C	200°C
Dehydrated Fruits & Vegetables	0	100%	→	→	→	→	→	→	→
Concrete Block - Low Pressure	0	100%	→	→	→	→	→	→	→
Autoclave	0	0	0	0	0	0	0	100%	→
Frozen Fruit & Vegetables	0	0	39%	100%	→	→	→	→	→
Poultry Dressing	100%	→	→	→	→	→	→	→	→
Meat Packing	0	99%	100%	→	→	→	→	→	→
Prepared Feeds - Pellets	0	0	100%	→	→	→	→	→	→
- Alfalfa Drying	0	0	0	0	0	0	0	0	100%
Plastic Materials	0	0	0	0	0	0	0	0	100%
Dairy Industry - Cheese	23%	100%	→	→	→	→	→	→	→
- Condensed Milk	0	63%	63%	93%	100%	→	→	→	→
- Dried Milk	0	0	42%	66%	71%	71%	71%	100%	→
- Fluid Milk	0	0	100%	→	→	→	→	→	→
Soft Drinks	61%	100%	→	→	→	→	→	→	→
Soaps	0	0	0	1%	→	→	→	→	100%
Detergents	0	0	0	52%	→	→	→	→	100%

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coal in the future which may encounter environmental or other growth constraints. A cross matching of the hydrothermal resources, as known today and projected in the future, on a county-by-county geographical basis with the potential user sectors, has defined the prime areas to be developed. This analysis reveals that all 10 states within the RMB&R region have significant amounts of resources which correlate with potential energy market areas, and that the majority of the industrial and population centers are colocated with hydrothermal resources. The current energy use, considering all potential uses of direct heat, is 362 x 10^{12} Btu/yr with a growth potential by the year 2020 of 3980 x 10^{12} Btu/yr.

Many of the major industrial energy consumers of the RMB&R region can use low-to-moderate heat sources to meet a portion, if not all, of their energy needs. These industries include food and kindred products processing, wood and lumber products, mining and minerals, chemical processing, and the concrete industry. Table III lists the top prospects that are matched by counties with hydrothermal resources in the RMB&R region. The energy supply requirements of the industrial sector are somewhat smaller than the energy needs for residential/commercial space conditioning, but the region's growth potential is excellent and it appears that market penetration can more readily be made in the industrial sector. Current industiral energy use in the low-to-moderate heat processing sector which can be served by hydrothermal energy is 74 x 10^{12} Btu/yr with a growth pattern of 177 x 10^{12} Btu/yr by 1985, 480 x 10^{12} Btu/yr by 2000, and 1476 x 10^{12} Btu/yr by the year 2020. For the year 2020, this energy use equals approximately 250,000,000 barrels of oil per year.

Market growth projections for hydrothermal energy in the RMB&R region present an attractive profile. From the data illustrated in Figure 1, it is evident that a substantial portion of the region's energy needs can be satisfied by hydrothermal energy. Competition from conventional energy sources, as well as other alternative energy types (solar, biomass, etc.), result in choosing conservative market penetration rates as shown by the estimated penetration (bottom) curve.

From the foregoing considerations, it can reasonably be observed that: (a) substantial long-term markets for hydrothermal energy exist in the RMB&R region; (b) commonly found coincidence of resource occurrence with user locations promise favorable economics in competition with other energy supplies; and, (c) hydrothermal energy can, with appropriate stimulation and encouragement, be a near-term partial solution to the region's energy needs.

Barriers

For many years, oil and gas prices have been sufficiently low, through abundance and tax incentives, to suppress energy prices below that attractive for developing geothermal resources. Although the hydrothermal energy source is currently economic and capable of supporting industrial needs, one wonders why the industrial sector of the United States is not actively attempting to develop this energy source. A quick look identifies the major reasons for the lack of development interest. Those most easily identified are, (a) the energy is not transportable over large distances, (b) tax incentives have not favored this energy source, (c) the use potential is unknown, and (d) the resource base has not been well defined.

As the availability of oil and gas diminishes and the availability of new hydropower sites decrease, both fossil fuel and electrical energy costs will continue to increase, thus giving hydrothermal energy a more comfortable marketplace in which to compete. This leaves resource definition, the knowledge of potential use, and the lack of incentives the major previously identified barriers to overcome. DOE has programs in progress to help mitigate these problem areas. The major unsolved barrier, and one which was not previously identified, is the absence in the present marketplace of the infrastructure necessary to develop and deliver hydrothermal energy to the user sector.

References

[1]Howard, J. F., "Present Status and Future Prospects for Non-Electric Uses of Geothermal Resources", UCRL-51926, Lawrence Livermore Laboratory, October 15, 1976.

[2]Intertechnology Corporation, "Analysis of the Economic Potential of Solar Thermal Energy to Provide Industrial Process Heat", Volume 1, February 7, 1977, ERDA.

TABLE III
TOP 20 INDUSTRIAL PROCESS HEAT APPLICATIONS
DIRECTLY MATCHED[1] FOR GEOTHERMAL ENERGY REPLACEMENT
IN THE RMB&R REGION
(x 10^{12} BTU/YR)

INDUSTRY	MATCHED 1975 ENERGY USE[2]	INDUSTRY	MATCHED 1975 ENERGY USE[2]
Dehydrated Fruits & Vegetables	11.80	Inorganic Chemicals	1.06
Concrete Block	7.10	Ready-Mix Concrete	.98
Frozen Fruits & Vegetables	5.24	Gypsum	.97
Poultry Dressing	4.82	Canned Fruits & Vegetables	.97
Meat Packing	4.45	Beet Sugar	.82
Prepared Feeds	3.65	Treated Minerals	.69
Plastic Materials	3.63	Cotton Seed Oil Mills	.34
Dairy Industry	3.24	Prepared Meats	.34
Soft Drinks	2.91	Pharmaceuticals	.25
Soaps	1.24	Furniture	.21

(1) Industries matched by colocation with resources and compatible process temperatures in those counties having hydrothermal resources.

(2) Regional consumption of direct heat energy in 1975 replaceable by hydrothermal energy from colocated and temperature-matched resources.

FIGURE 1
ENERGY CONSUMPTION PROJECTIONS
FOR THE RMB&R REGION