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**GEOHERMAL APPLICATIONS
FOR A TANNERY**

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MASTER

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Idaho Falls, Idaho 83415

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ABSTRACT

This report summarizes the tanning process and associated energy requirements. It appears that a significant economic impact may be possible if a shallow hydrothermal resource of approximately 150 to 170°F (66 to 77°C) were found, and the fluids were cascaded to produce the temperatures necessary for the various tanning operations. The hydrothermal energy would have to be cost competitive with the rapidly escalating fossil energy costs. Although one would need to thoroughly analyze the technical, environmental, and economic issues of such an application, this initial review indicates a good match between the process and potential hydrothermal resources.

FOREWORD

The Geothermal Technical Assistance Program was developed under the premise that the majority of groups or individuals with available geothermal resources do not have the experience or manpower necessary to do a preliminary engineering and economic feasibility evaluation for geothermal energy projects. In order to disseminate technical information and to facilitate expanded use of geothermal energy resources, assistance was provided through FY-1981 in a consulting format on a first-come, staff-and-funds-available basis. Technical assistance can relate to conceptualization; engineering; economics; water chemistry implications for environmental, disposal, and material selection considerations; and planning and development strategies. This report is one of a series adapted from consultation provided to requesters either through in-house efforts or through limited efforts sub-contracted to local engineering firms. The Geothermal Technical Assistance (GTA) reports in this series, which are listed below, will be available early in 1982 to those with interest in specific geothermal applications.

<u>GTA Report No.</u>	<u>EG&G Report No.</u>	<u>Title</u>
1.	EGG-GTH-5512	<u>Aquaculture Facility Potential at Boulder Hot Springs, Boulder, Montana</u>
2.	EGG-GTH-5521	<u>Preliminary Geothermal Disposal Considerations, State Health Laboratory, Boise, Idaho</u>
3.	EGG-GTH-5573	<u>Geothermal Conversion at Veterans Hospital, Boise, Idaho</u>
4.	EGG-GTH-5574	<u>Geothermal Applications for Highway Rest Areas</u>
5.	EGG-GTH-5575	<u>Geothermal Applications for a Tannery</u>
6.	EGG-GTH-5599	<u>Preliminary Conceptual Design for Geothermal Space Heating Conversion of School District 50 Joint Facilities at Pagosa Springs, Colorado</u>
7.	EGG-GTH-5617	<u>Selected Geothermal Technical Assistance Efforts (comprising short descriptions of ten space heating projects, five district heating projects, and three heat exchanger projects)</u>

<u>GTA Report No.</u>	<u>EG&G Report No.</u>	<u>Title</u>
8.	EGG-2137	<u>Geothermal Source Potential and Utilization for Methane Generation and Alcohol Production (subcontractor report)</u>
9.	EGG-2138	<u>Geothermal Source Potential and Utilization for Alcohol Production (subcontractor report)</u>
10.	EGG-2139	<u>Potential Geothermal Energy Applications for Idaho Elks Rehabilitation Hospital (subcontractor report)</u>
11.	EGG-2144	<u>Technical Assistance Report on a Geothermal Heating Utility for Lemmon, South Dakota (subcontractor report)</u>
12.	EGG-2145	<u>Economic Analysis for Utilization of Geothermal Energy by North Dakota Concrete Products Company (subcontractor report)</u>
13.	EGG-2146	<u>Geothermal Feasibility Analysis II for Polo School District No. 29-2, South Dakota (subcontractor report)</u>
14.	EGG-2147	<u>Preliminary Feasibility Study of Heating and Cooling Alternatives for Nebraska Western College, Scottsbluff, Nebraska (subcontractor report)</u>
15.	EGG-2148	<u>Inventory of Thermal Springs and Wells Within a One-Mile Radius of Yucca Lodge, Truth or Consequences, New Mexico (subcontractor report)</u>
16.	EGG-2149	<u>Space Heating for Spa Facilities at Ojo Caliente, New Mexico (subcontractor report)</u>
17.	EGG-2150	<u>Geothermal Heated Office Building at Glenwood Springs, Colorado (subcontractor report)</u>
18.	EGG-2151	<u>Final Report--Dickinson Geothermal Study, Dickinson, North Dakota (subcontractor report)</u>
19.	EGG-2152	Cancelled
20.	EGG-2153	<u>Comparison of Two Options for Supplying Geothermal Energy to the Veterans Administration Medical Center, Marlin, Texas (subcontractor report)</u>

<u>GTA Report No.</u>	<u>EG&G Report No.</u>	<u>Title</u>
21.	EGG-2154	<u>Geothermal Utilization at Castle Oaks Subdivi- sion, Castle Rock, Colorado (subcontractor report)</u>
22.	EGG-2155	<u>Space Heating for Twin Lakes School Near Gallup, New Mexico (subcontractor report)</u>
23.	EGG-2156	<u>Pumping Tests of Well Campbell Et Al. No. 2, Gila Hot Springs, Grant County, New Mexico (subcontractor report)</u>
24.	EGG-GTH-5739	<u>Geothermal Deicing of Highways and Bridge Structures</u>
25.	EGG-GTH-5740	<u>Assessment of a Geothermal Application at Tucson, Arizona</u>
26.	EGG-GTH-5741	<u>Heat Pump Systems for Spring Creek, Montana</u>
27.	EGG-GTH-5779	<u>Pipe Selection Guide</u>

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GEO THERMAL APPLICATIONS FOR A TANNERY

INTRODUCTION AND SUMMARY

The tanning industry is centered in the New England area where the source of hides is plentiful. However, growth of the industry has fallen off in the last decade due to the economic competition of foreign tanners and the expenses incurred for pollution control. The heavy reliance on brines, acids, and chromium solutions creates significant capital investments and has impacted the competitive edge the United States once had. Nevertheless, if significant energy cost savings could be realized in the operations by using geothermal energy, perhaps this industry could become more competitive.

This report summarizes the tanning process and associated energy requirements. It appears that a significant economic impact may be possible if a shallow hydrothermal resource of approximately 150 to 170°F (66 to 77°C) were found, and the fluids were cascaded to produce the temperatures necessary for the various tanning operations. The hydrothermal energy would have to be cost competitive with the rapidly escalating fossil energy costs. Although one would need to thoroughly analyze the technical, environmental, and economic issues of such an application, this initial review indicates a good match between the process and potential hydrothermal resources.

THE TANNING PROCESS

Description

The tanning process is tailored to the needs of the tanner's commercial customers. Tanning may be accomplished with chromium compounds, natural vegetable tannins, or synthetic tanning agents. Generally, only heavier saddle and sole leathers are still tanned with vegetable tannins. Chrome tanning has cut processing time from weeks to days. After the actual tanning, the leather may be split, trimmed, oiled, and dried, using a variety of techniques to obtain the desired properties. Final finishing may include spraying several coats of oils and stains. The tanner and equipment must be flexible enough to meet a variety of customer specifications.

Figure 1 illustrates the basic process flow for a chrome-tanned cattle hide operation. Hides come from meatpacking houses in a variety of conditions, but commonly, the hide will have had the flesh removed and will be brine-cured to prevent putrefaction. The tanner must first inspect the hides for irregularities. The hides are then washed and soaked to rehydrate the skins.

Liming is the first chemical treatment. Hides are soaked in a 10% lime and sodium sulfide solution that loosens the epidermis and hair. This may be done in open pits, tanks, or drums and may be done with or without hair recovery. If hair recovery is not important, the hair is abraided in the same drum liming. If hair is to be recovered, the hides must be removed from the drums, placed in cutting machines, and reloaded into the drums. Traditionally, this added labor cost has been marginally justifiable.

Bating performs two important functions. First, the hides are delimed with the addition of ammonium sulfate. Second, the cell structure is modified, through treatment with proteolytic enzymes, to accept tanning agents. Bating reduces the swelling associated with the liming operation. The

Basis: One defleshed, brine-cured cattle hide

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Figure 1. Chrome-tanning process flow.

solution/hide weight ratio in the bating operation may vary from 2:1 to 4:1. The temperature varies with the type of leather and the enzyme used. At temperatures above 90°F (32°C), shrinkage of the hide and consequent loss of product may occur.

Pickling is the first step of chrome tanning. The hides are treated with mineral acid to lower the pH value. The actual pH is related to the chromium system used. Tanning itself, in which chromium combines with protein fibers, is then carried out in the same wooden drums or in specially lined "cement mixer" type tumblers. The tanning process may require up to 24 hours. The temperature is slowly raised from the bating temperature up to a maximum of about 130°F (54°C). Solution/hide "float ratios" average between 1.25 and 1.75. The average temperature, a balance between facilitating absorption of the tanning agents and avoiding shrinkage and gelatinization, is between 115 and 120°F (46 and 49°C). The solution is brought to temperature by heating a recirculating stream of solution with live or indirect steam. Temperature is maintained by the friction from the tumbling hides.

After the tanning, hides are thoroughly washed in the drum. Cattle hides may then be split with continuous-band knives to give lighter, more supple leathers. The leather is then divided into lots to be processed for specific customer specifications. At this point, several options are available.

Generally, chrome-tanned leather requires dyeing. Also, retanning is sometimes used to develop certain properties in the finished product. A third process, fat liquoring, involves treating the leather with an oil-water emulsion to lubricate the leather fibers and make them more flexible. All three options are carried out in small-batch drums. "Float" ratios vary from 3:1 to 1.5:1. As before, temperature is controlled by indirect heat exchange with the solutions. Temperature is maintained by the frictional heat developed in the leather. This entire drumming procedure may last from 30 minutes to 2 hours. Once again, the hides are washed in the drums. The hides are then removed and mechanically wrung out.

There are presently several alternate drying processes, including toggling, vacuum drying, and paste drying. Paste drying and vacuum drying are used for most cattle hides. Toggling is used primarily for light leathers. Very heavy belt and harness leathers may be dried in large lofts at slightly elevated temperatures. Paste drying involves covering the grain side of the leather with a starch paste and stretching the leather across a plate. This plate passes through a drying tunnel with a maximum temperature of about 150°F (66°C). Residence time is on the order of 1 to 2 hours. Vacuum drying involves placing the hide on a perforated table and subjecting it to both heat and vacuum. Both drying procedures reduce the moisture content of the leather to about 12%. Final leather temperature should not exceed 110°F (43°C).

Finishes are applied to the leather in the equivalent of commercial paint spray booths. OSHA requirements necessitate high ventilation-face velocities in these booths. One to four coats may be used. Finishes may be water-based or solvent-water emulsions. Solvent finishes evaporate instantaneously, but emission problems limit their use. Water-based finishes are applied to an average coating thickness of 25 mils. The water is driven off in drying tunnels operated at 160 to 170°F (71 to 77°C). The quick drying evaporates the water in the finish without drying the leather.

Energy Use

Estimated energy consumption figures for the various unit operations appear in Figure 1. The individual values were calculated from thermodynamic data, actual plant data, and equipment data supplied by vendors. The generalized process requires about 150,000 Btu per hide (1.6×10^8 J).

Data on fuel consumption and thermal efficiency appear in Tables 1 and 2. The tanning industry relies heavily on gas, specifically gas-fired, steam-generating boilers. Some southern tanneries use gas for direct-fired dryers.

TABLE 1. FUEL USE IN TANNING AND FINISHING (1971)

Fuel	Quantity	Heat Value	
		Btu	J
Distillate	353,600 bbl	2.06×10^{12}	2.17×10^{15}
Residual	432,100 bbl	2.70×10^{12}	2.85×10^{15}
Coal	97,700 s. t.	2.53×10^{12}	2.67×10^{15}
Gas	4.6×10^9 ft ³	4.75×10^{12}	5.01×10^{15}
Other, not specified		4.44×10^{12}	4.68×10^{15}

TABLE 2. THERMAL EFFICIENCY OF DIFFERENT FUELS IN TANNING

Fuel	Thermal Efficiency	Millions of Hides
Distillate	75	10.3
Residual	75	13.5
Coal	65	11.0
Gas	80	25.3
Other	75	22.2

The maximum processing temperature used in leather tanning and finishing is well below 200°F (93°C). Consequently, process heat requirements are adaptable to moderate- to low-temperature hydrothermal resources. The processing solutions could be heated by standard heat exchangers. Flat-plate exchangers have been proved adaptable in both geothermal and industrial applications. Moderate- to low-temperature resources could also be used for plant drying, makeup air heating, and space-heating requirements.