The San Michkael Project, an Example of Multiple Direct Uses of Low to Medium Enthalpy Geothermal Source for Developing Countries

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ABSTRACT

With temperatures ranging from 90 to 120 degrees Centigrade, the San Michkael Geothermal Industrial Park Project, in Guatemala, Central America is working in multiple direct applications of their geothermal well using the temperature in cascade after each use. Our business model which includes practical approaches, apply a shallow low to medium temperature geothermal well source in direct use applications. Among which are: Electricity Generation, Food, Grains, Fruits and Vegetable Dehydration, Wax and Candle Handy Crafts, and Hot and Cold Water Production for multiple Industrial uses. Other such as Cold Storage and Vapor applications are being evaluated. The method can be easily applied in developing countries with a small budget, most of the equipment and facilities built with local off of the shelf equipment. The geothermal exploration, geothermal well drilling and site exploration and development done in-house by the San Michkael Geothermal Project. This business and technical model can be applied to other projects and locations with similar conditions as the ongoing growing knowledge of each geothermal source is determined. Waste water from large geothermal operations can also be alternatively used. The project is a sample of what can be achieved with a shallow geothermal source to set up a profitable and self-sustained business. It is a tool that can help communities to attain self-sufficiency and generate income using direct low enthalpy geothermal applications.

1. INTRODUCTION

It is the purpose of this professional essay to be practical and narrative, describing the different activities done by "SAN MICHKAEL GEOTHERMAL PROJECT" in Guatemala. Specific information related to any of the stages of this project can be obtained directly from the author.

Eight years ago, the San Michkael geothermal Project initiated activities in the area of Amatitlan, Guatemala, Central America with the main objective to find a geothermal source that could be used commercially by producing its own electricity and using direct geothermal source applications.

All the tasks related to this project such as gathering and analysis of previous existing information in the area, exploration and drilling activities, land acquisition and development, installation design and construction, equipment design and modifications of existing off of the shelf equipment and facilities construction, and the development of its own studies and research were done by San Michkael, S.A. personnel. This project has been partially supported by the AEA (Energy Alliance for Central America (AEA) a program of the Secretariat of Integration for Central America, SICA) and GIZ (Deutsche Gesellschalt für Internationale Zusammenarbeit).

Aimed to minimize cost, previously existing information was evaluated and reviewed in order to proceed with the project. It is estimated that the available information had an equivalent value of between than \$2,000,000 - \$3,000,000. Most of these previous work and studies were originally focused on geology, geophysics and geochemistry and other related subjects, to evaluate the geothermal potential of the area. The studies were done and financed by International and Guatemalan government agencies in programs aimed to locate prospective "high enthalpy geothermal resources in the region" during the nineteen seventies and eighties. As a result of the initial assessments, some shallow geothermal wells were drilled in the area with certain degrees of success but none of them finding yield temperatures and pressures to qualify as a high geothermal producer under the scale qualification standards of those programs. Since the original findings in the area did not meet the requirements of high temperature and pressures expected, the area was declared as not high interest anymore and the information was made public under the public information laws of Guatemala.

MESON SAN MICHKAEL, S.A., after reevaluating all available information, developed its own prospection and exploration program, and proceeded to locate an optimal location with high potential for low enthalpy. A parcel of land was bought in order to continue with a drilling program aimed to further explore the location to exploit the geothermal resource for low to medium direct geothermal applications.

2. PROJECT LOCATION

The SAN MICHKAEL GEOTHERMAL project, is located in Amatitlan, 29 Kms. away from Guatemala City.

Figure 1: Project Location, South of Guatemala City, Central America.

3. PROJECT OBJECTIVES AND DESCRIPTION:

The San Michkael Geothermal Project belongs to a group of sister companies focusing on earth sciences, drilling, engineering, construction and developers of warehouses and self-storage income producing real estate.

The San Michkael Geothermal Project was created as a dedicated activity among the business conception and land development of our sister companies. Having in-house capabilities in most of the specialties needed to tap into the geothermal energy helped us to achieve the success of the project and to create aggregated value to the use of land. The project is an ongoing activity and it is comprised of six warehouses, with planning to expand to ten warehouses. Each warehouse hosts renters of different businesses and factories that use temperature in their processes. That need for energy, knowing the geothermal potential of the area, motivated us to initiate the project.

This project model can be expanded to other countries and locations. Countries with shallow reservoirs can tap the geothermal resources easily and take advantage of previous exploration programs that may have available information. Countries that are already working with high enthalpy geothermal energy, have the advantage of using residual waters that if not used, will end up sitting in cooling reservoirs, wasting money in temperature and vapor energy released, without any further use and expelled to the environment or re-injected into the ground. The use of residual geothermal water may prove a strong tool to work together with communities and improve the living standards of the population and create new work sources and industries. Figure No.2 shows the 1.6 acres (+/- 6,500 square meters) parcel of land where the project is located.

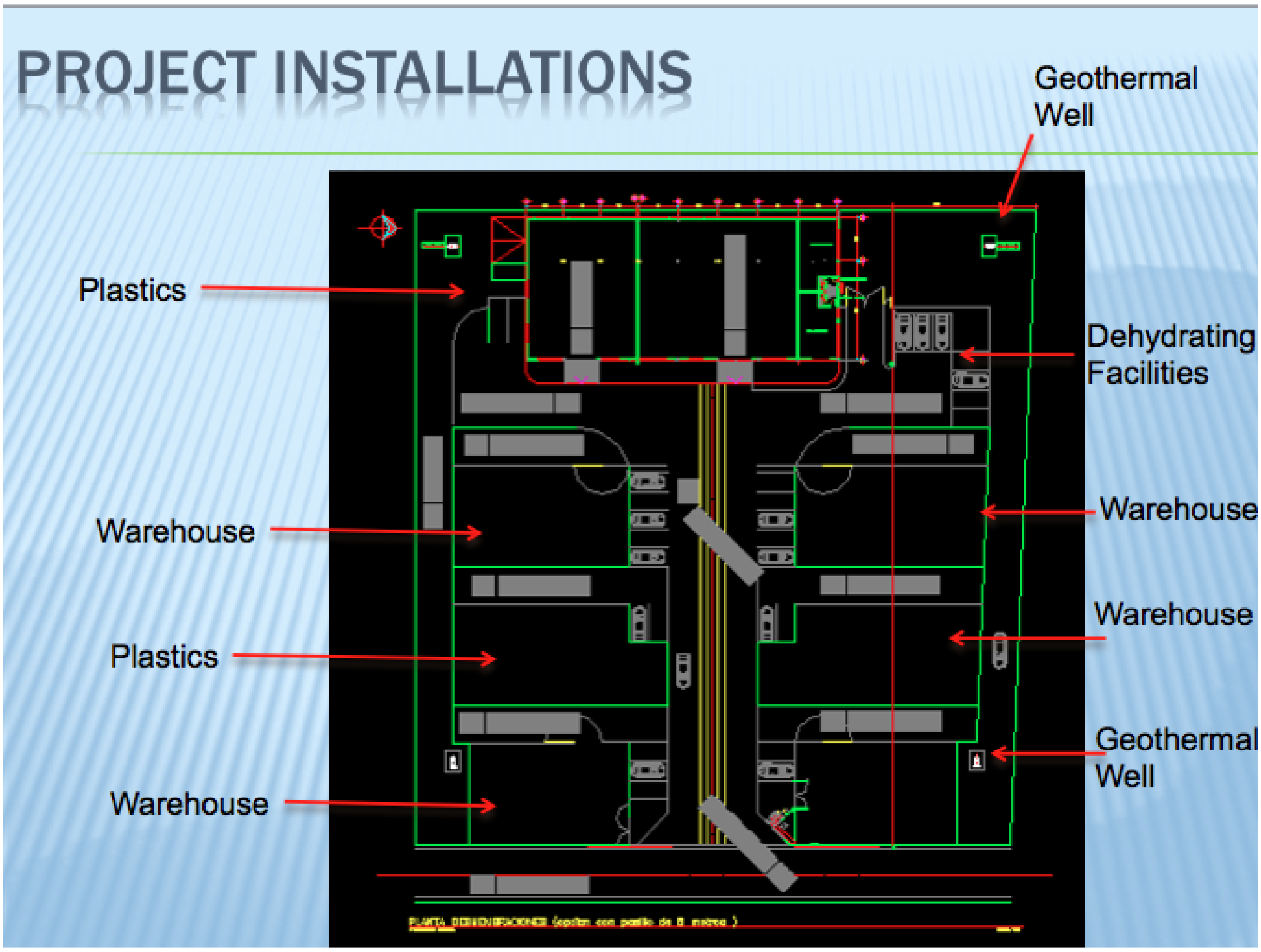

Figure 2: Project Plan using geothermal energy in different industries.

Among the requirements to determine this optimal location of the project and in order to reduce cost and investment were: 1) Price of land. 2) Existence of a high geothermal potential. 3) Shallow geothermal reservoir. 4) Optimal Location and accessibility. 5) Near a major city and major highway. 6) Nearby proximity of Markets to sell the products and to plantations to obtain raw materials such as cheap vegetables and fruits to dehydrate. 7) Existence of basic services such as electric lines, internet, water, etc. 8) Existence and prompt availability of Earth Science Information of the area.

With the main objective being the use of geothermal energy and focusing on industrial applications, the SAN MICHKAEL GEOTHERMAL PROJECT is located in the vicinity of high population areas, strategically located on the outskirts of Guatemala City within highways connecting to the main crop producing regions and on the main highway used to move all the goods imported and exported to and from Asia and the Pacific region and in one the principal industrial centers of Guatemala.

Previous history of direct geothermal energy use industries exists in the area. A construction block factory used vapor to cure its products, a Fruit dehydrating plant worked with pineapple and other vegetables in the past, and a Lemon dehydrating company uses geothermal energy and exports lemons to the middle east.

Figure 3: Project Location in populated Industrial Area.

SAN MICHKAEL GEOTHERMAL project engineers, after doing a detailed exploration program in the area, decided to proceed further into a chosen location to drill an exploration well (San Michkael-1/SM-1) which was highly successful and provided vital information. A high water table was found and the exploration well showed temperatures ranging from 120-140 degrees Centigrade at shallow depths (less than 60 meters).

Figure 4: Shallow Exploratory well SM-1, Logging equipment recording SP and Resistivity.

After evaluating the obtained information and updating the existing data and studies on hand, the project continued by drilling another larger well (San Michkael-2/SM-2) at the location. This well gave temperatures of 140-160 degrees Centigrade and pressures around 40 P.S.I (in static conditions) at depths of less than 200 meters.

Figure 5: Setting the 14 inches casing in SM-2 Geothermal Well.

Figure 6: Cementing the well head and installation of main Valve in well SM-2

An in-depth evaluation of this well was made to understand its capacity and to apply its temperature and pressure to direct industrial uses. Several sources of information were researched (Mujundar, 2006), (Lienau and Lunis,1989) and initial potential applications of the available geothermal resource chosen.

Figure 7: well SM-2 Flowing after setting up Casing.

Figure 8: well SM-2 With Control Valve.

Some of the industrial applications and ranges of temperatures that are used in industrial processes, are within the ranges obtained on SM-1 and SM-2. As a matter of fact most of the range of applications as described on the Figure No.3 were covered.

Figure 9: Well SM-2 Flowing

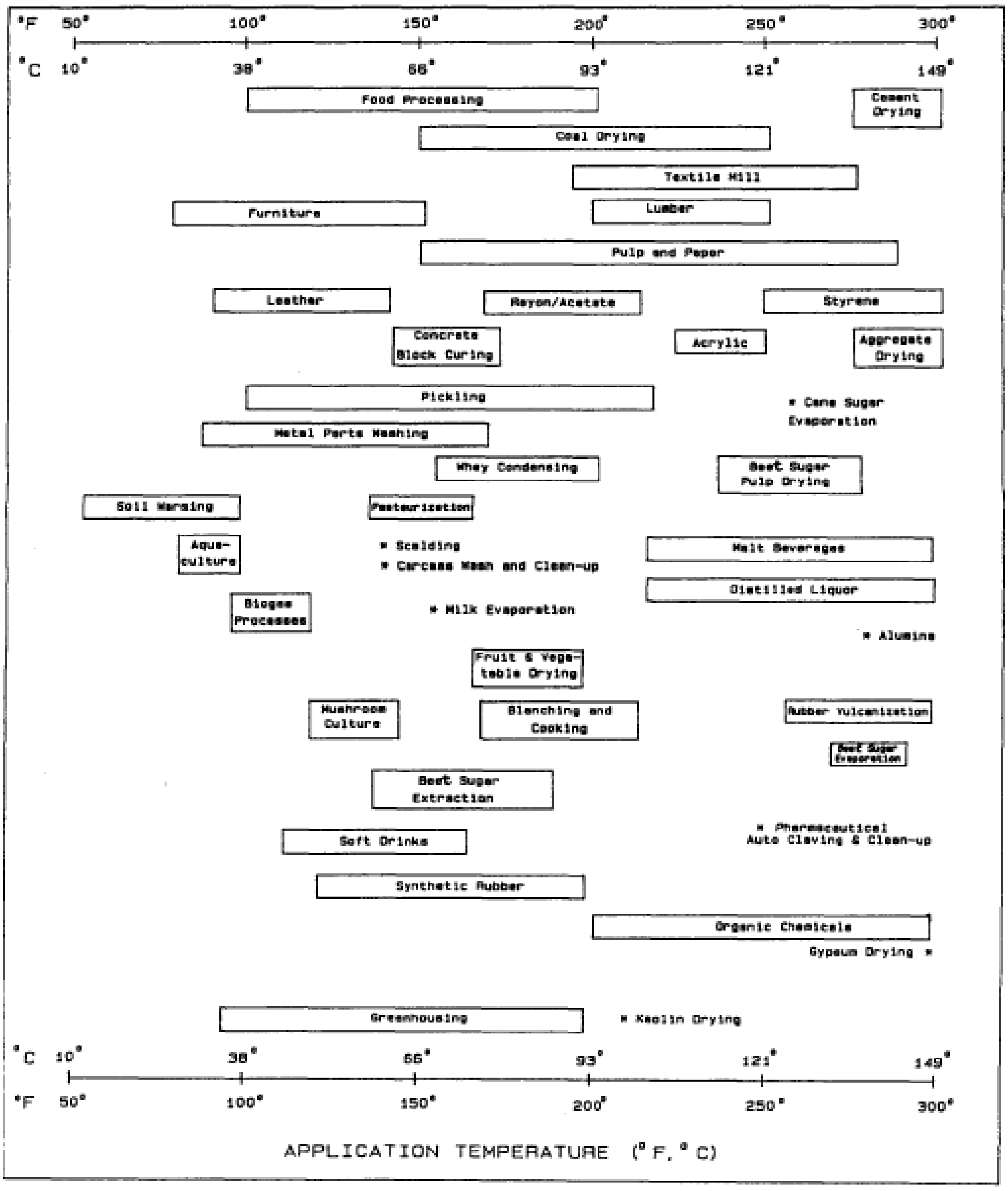

Figure 10: The figure shows some industrial and agricultural processes and the different ranges of temperature used. (Mujundar, 2006).

4. DIRECT CASCADE GEOTHERMAL ENERGY APPLICATIONS IN THE PROJECT:

The cascade concept of using the geothermal source in our project is described in Figure No.11

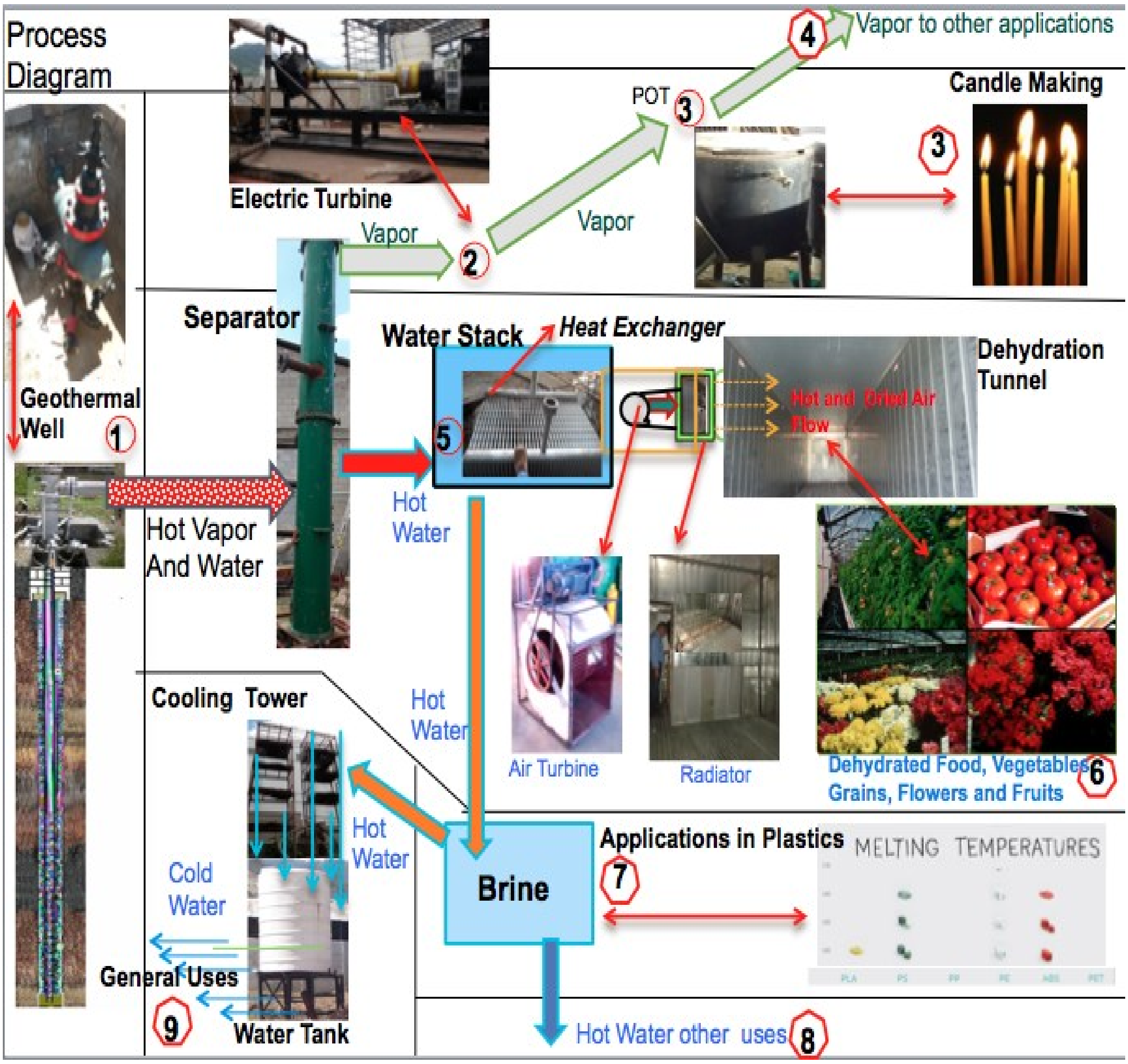

Figure 11: Diagram showing the cascade flow of the geothermal source and some of the actual applications (with encircled numerals) as the water and vapor temperature decreases.

Water and vapor flows from the well at temperatures of 110-140 degrees Centigrade (depending if the well is flowing in full or partially flowing). A Centrifugal separator was built (Numeral No.1, Figure No.11) to generate a Vapor and a Water Phase.

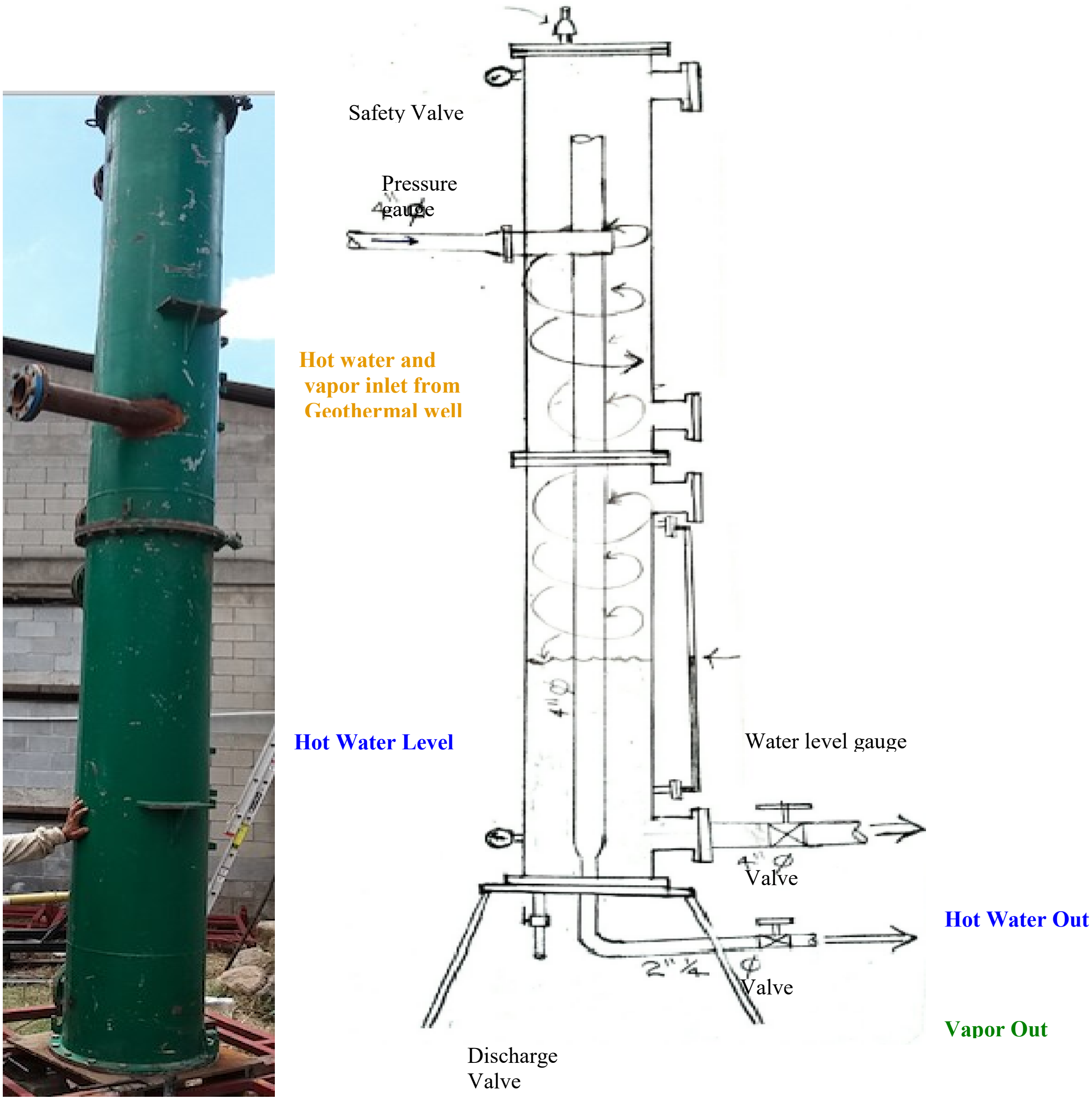

Figure 12: Water and Vapor Centrifugal Separator and a schematic working cutoff.

4.1 Vapor Phase and Applications:

A stable flow of hot vapor coming out of the Centrifugal Separator is sent to a low pressure and temperature experimental turbine (Quasiturbine, Figures No.11 and 12) to generate 20-25 Kw (Numeral No.2, Figure No.11).

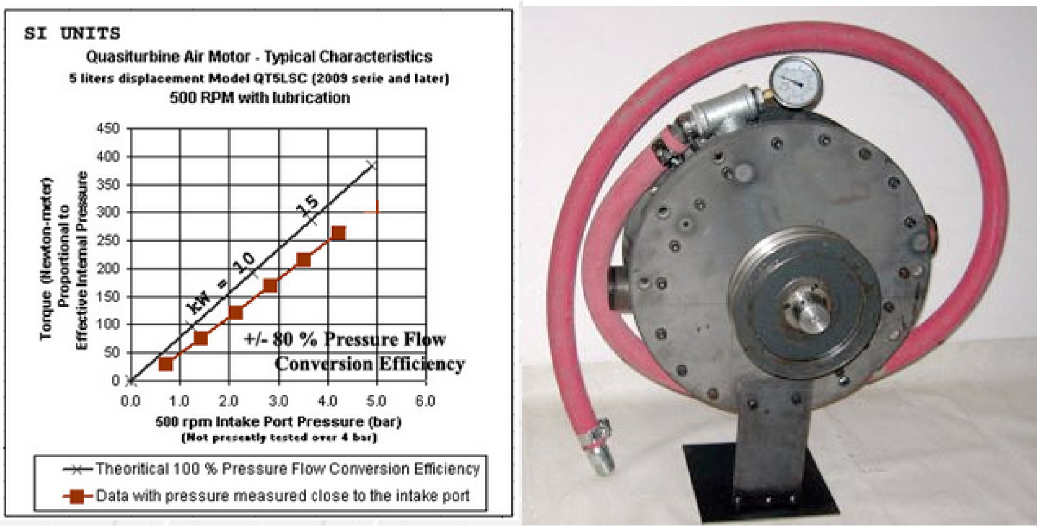

Figure 13: Quasiturbine QT5LSC performance under low pressure-temperature conditions.

Figure 14: QT5LSC Quasiturbine Attached to the electrical generator.

After powering the turbine, the vapor flows to an industrial Pot (Numeral No.3, Figure No.11). to heat Paraffin that, after melted, is poured into molds for Candle Making. The vapor is then released in to the atmosphere; however, other uses such as steam cleaning of a recycling dpt plastic operation in the project is being assessed to take advantage of the remaining energy of this vapor with a temperature that ranges 50-60 degrees centigrade (Numeral No.4, Figure No.11).

4.2 Water Phase applications:

A stable flow of hot water coming out of the Centrifugal Separator is sent into a heat exchanger (Figure No.6) installed inside of a water stack (Numeral No.5, Figure No.11) A special explanation will be made of this specific use of the water since it activates the vegetable dehydrator circuit which is a separate loop.

After this stage, the hot water continues to a water tank (Brine, Numeral No. 7, Figure No.11) where more uses are being assessed such as preheating or cleaning plastic materials or parts. From this tank water is pumped to a cooling tower were it is completely cooled down and could potentially be used as a counterpart of cool water for any other heat exchanger process (Binary electric production, Heat Pumps, and Cool Storage) or used directly in crop irrigation or industrial processes according to its chemical composition.

4.2.1 Air Turbine Dehydrators:

Dehydrator separate loop: When the hot water coming from the Centrifugal Separator and inside the heat exchanger transfers its temperature to the water in the water stack (Numeral No.5, Figure No.11) (it is completely independent and belongs to a separated closed circuit), the hot water from the water stack is pumped through two water radiators inside the dehydrator tunnel and high volume air turbines blow air though the radiators into an air tunnel where food, vegetables, grains and fruits are dehydrated in trays placed on special carts. (Numeral No.6, Figure No.11) Figures No. 14 and 15. It is estimated that this facility can process 1-1 1/2 tons of vegetables and fruits a day to produce dehydrated products.

Figure 15: Off the shelf air conditioner/heat exchanger used in the refrigeration industry made of stainless steel and installed inside the water stack where the hot water of the well flows.

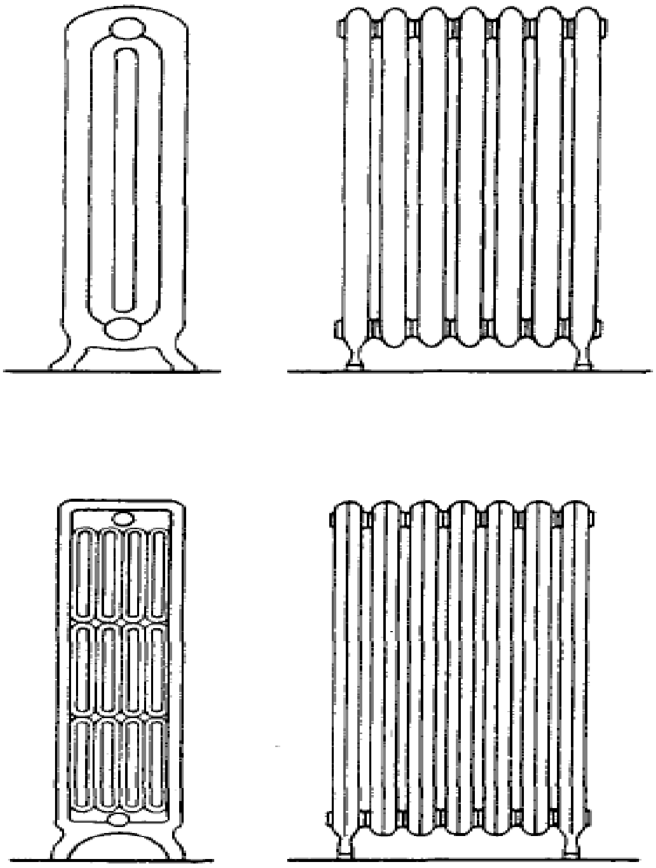

Figure 16: Heat Exchanger for dehydrating (Mundanar, 1979).

Figure 17: Converted Refrigerated Shipping Container into the Dehydration Tunnel. Regular shipping containers converted into the vegetable cutting and preparation area and lab.

Figure 18: Converted Refrigeration Radiators into to the main Radiator in the dehydration air tunnel. Dehydration trays.

During the research, planning, construction and development of this project, many obstacles were solved by innovation and research. The use and modification of available off of the shelf equipment and the design and fabrication of our own equipment in our shop has proven to be invaluable. This was extremely important to reduce cost, and in-house learning and experience capabilities were established allowing us to continue further into other direct geothermal applications that may prove to be profitable.

4.3 Extended Application under Assessment:

Other direct geothermal applications are presently under evaluation such as Cold Storage and Electric Generation using Peltier modules.

4.3.1 Cold Storage:

Several companies manufacture cooled space units that use geothermal heat as a source of energy. A basic diagram is described by Harris, et al, where a secondary loop is created to produce cold by using refrigerant solutions and heat exchangers acting also as condensers and absorbers.

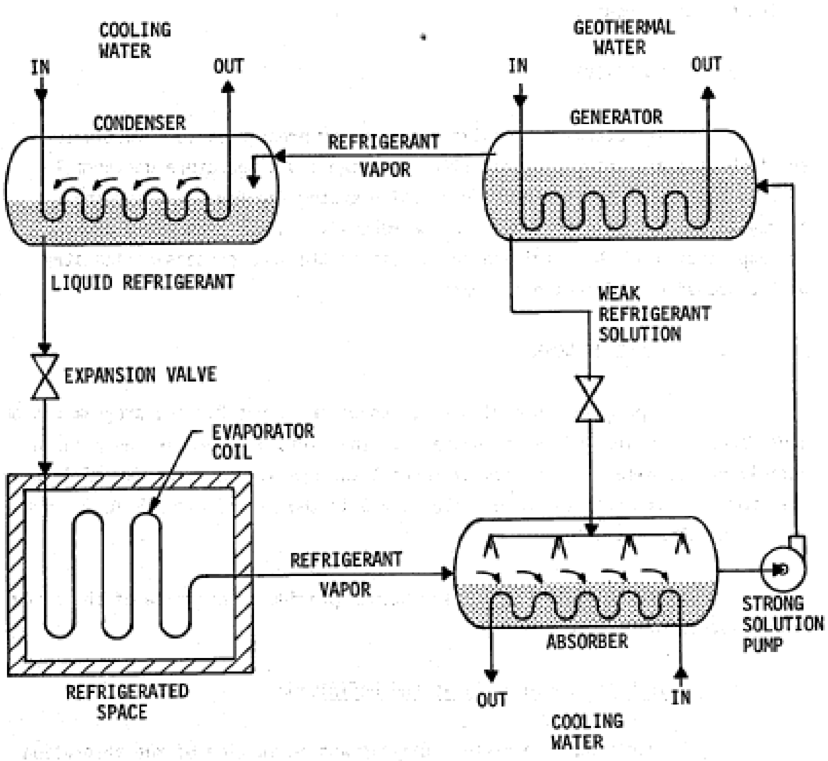

Figure 19: A diagram showing the potential application of the hot geothermal source to produce Cool Storage. (Harris, et, al)

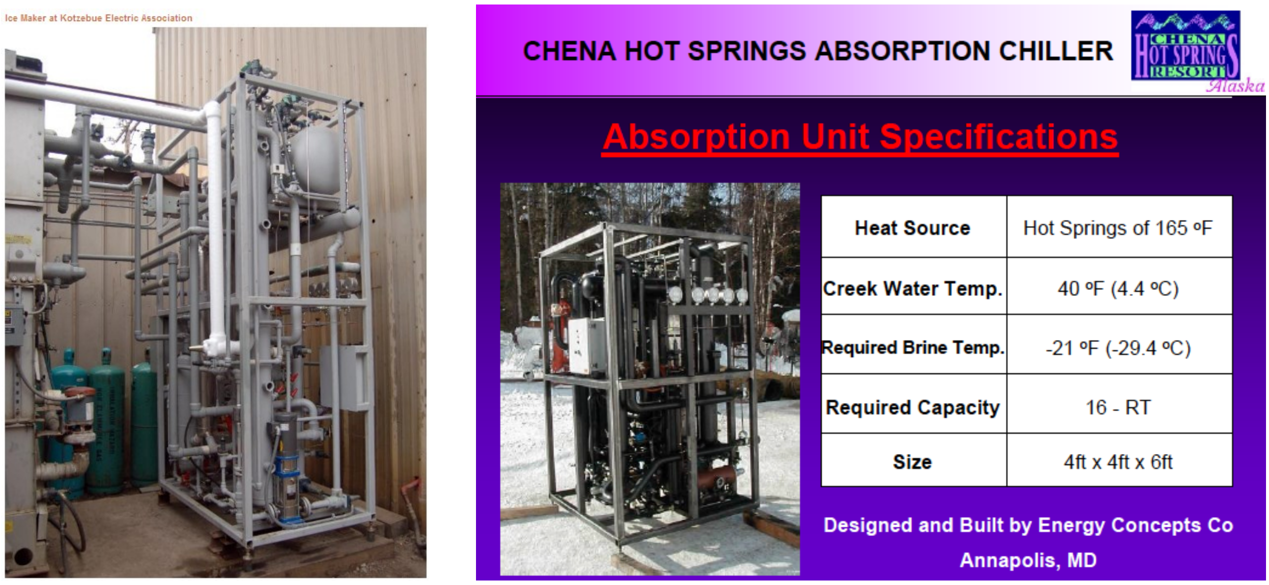

Figure 20: Modular units from Kotzebue Electric Association and at Chena Hot Springs Project in Alaska (Holdmann, G.)

This potential application is presently being assessed in the project. It is definitely an attractive option to generate income added value to any space that con be implemented with cold storage installations. Our project has implemented a 12 meter Refrigerated Container as a testing unit as a dehydrator tunnel and can be used for future evaluations of the cold production application. The idea of using refrigerated shipping containers is a very useful tool. Since they are self standing and no costly additional construction is needed. They can simply be located inside regular warehouses and the system can grow as the geothermal resource allows and the project requires.

4.3.2 Peltier and Electrical Generation:

Just recently the existence of the Peltier Modules and their capacity to produce electricity by a temperature differential between two plates made up of two different materials has come into our attention. At this moment the superficial evaluation of this technology showed that it is interesting technology but the amount of electric energy generated is very small, unless high numbers of these plates are used. However, it may be worthwhile to research it further.

5. CONCLUSIONS

The cascade degradation of temperature and pressure using direct geothermal energy is applicable to different industries reducing cost and increasing profitability, therefore it is being applied in the project. The model of this project can be exported to other locations all around the world creating applications for industries, communities, recreation, reinforcing food sources and creating new jobs and businesses. It is our hope to be able to create from this project, a demonstration project for everyone to see.

The main drawback of geothermal projects is their high cost and investment. The risk is minimized by tapping into existing geothermal sources to use residual and waste waters, and previous geothermal site investigations. Since the temperature ranges are not too high (<140 degrees), the geothermal resource is shallower allowing less expensive investments. Most of the equipment used and the plant installations were made or modified "in house" from off of the shelf equipment making the project less expensive and leaving us with the "know how and experience" within our company. This gives us a great deal of flexibility to work within the project. Other uses and applications are being presently assessed, among them Cold Storage.

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