Presented at "Short Course VI on Utilization of Low- and Medium-Enthalpy Geothermal Resources and Financial Aspects of Utilization", organized by UNU-GTP and LaGeo, in Santa Tecla, El Salvador, March 23-29, 2014.

UNITED NATIONS UNIVERSITY
GEOTHERMAL TRAINING PROGRAMME

LaGeo S.A. de C.V.

GEOTHERMAL ENERGY UTILIZATION AT OSERIAN FLOWER FARM-NAIVASHA

Martha Mburu
Geothermal Development Company
P.O. Box 1453-20117 Naivasha
KENYA
mmburu@gdc.co.ke

ABSTRACT

Oserian Development Company Limited (ODCL) is a privately owned farm located in Naivasha next to the Olkaria Geothermal project. The farm has been utilizing geothermal energy for direct use applications since 2003 and for electrical power generation from 2004. For Oserian, the use of geothermal energy has resulted in reduced operation costs, increased productivity, and a large market share due to use of environmentally and eco-friendly practices.

Oserian Development Company heats 50 hectares of rose flower greenhouses using geothermal energy from well OW-101 leased from KenGen in 2003.

KenGen and Oserian entered into a steam supply agreement for supply of steam from wells OW-306 and OW-202 to the two power plants at the Oserian farm. The power generated from the two plants is used for internal operations within the farm.

1. INTRODUCTION

Oserian is located adjacent to the Olkaria geothermal field in Naivasha. It began as a family owned vegetable growing farm in 1969, with a 5 hectare production area and 6 employees. In 1982 they expanded the farm to include cut flower production. Today, Oserian is one of the largest flower producers in Kenya, selling its products to Europe with a 30% share of the cut-flower market (ArGeo C2, 2008). Oserian now stands at the forefront of the industry as a leading force and one of the largest multi–crop, flower farms in Kenya (Figure 1).

In early 2000, the farm initiated a major investment program to utilize the geothermal energy from an early exploration well, well OW-101, leased from KenGen.

2. GEOTHERMAL ENERGY UTILIZATION AT OSERIAN

In early 2000, Oserian decided to move forward with an innovative strategy to harness geothermal energy. Its vision was to develop a technologically advanced growing method based on the full environmental control of its greenhouses and farm operations (Murua 2011). This was in the expectation that the use of geothermal energy for greenhouse heating and electrical power generation using the already available wells (OW-306 and OW-202, leased from KenGen) would significantly reduce the

operation cost, improve productivity and increase the market share since geothermal energy is an environmentally benign, cheaper, indigenous and sustainable energy source.

FIGURE 1: Photo showing greenhouses at the Oserian Flower Farm

Oserian constructed a 2.0 MWe binary plant Ormat OEC to utilize fluid from well OW-306. The plant, which is supposed to provide electrical power for the farm's operations, was commissioned in July, 2004. Oserian who grows cut flowers for export is also utilizing steam from a 1.28 MWe well to heat fresh water through heat exchangers, enrich CO_2 levels and to fumigate the soils.

2.1 Direct utilization

Oserian Development Company Limited, ODCL, is the only company in Kenya to utilize geothermal energy for direct use applications on commercial scale. A total of 50 hectares of cut rose flower greenhouses are heated using geothermal energy.

2.1.1 The greenhouse heating system

A low output-cyclic exploration well drilled by KenGen was initially believed to be non-productive and therefore "useless". The well, drilled to a depth of 1617m, encountered a maximum temperature of 278°C with a steam flow rate of 14.7 tonnes per hour and an enthalpy of 1475 kJ/kg. The Oserian Farm however leased the well for use in greenhouse heating. Through a system of loops (Figure 2), hot geothermal fluid heats fresh water which is used as a heat transport medium to the greenhouse. Greenhouse heating assists in controlling relative humidity within the greenhouse especially the early morning hours when humidity tends to rise to about 100%. Reducing relative humidity to below 85% eliminates fungal infection and hence eliminates the use of chemical fungicides. Heated water is also used to sterilise the fertilised water reducing fertiliser wastage and hence reducing cost. Carbon dioxide from the well is piped to the greenhouses in order to enhance photosynthesis.

Heating also enhances growth, increases productivity and saves on fuel costs that would be incurred if heating were to be done using fossil fuels (Hole and Mills, 2003).

FIGURE 2: Oserian greenhouse heating using geothermal energy

Inside a greenhouse, steel pipes are used to distribute the fresh, hot water around in order to attain the desired temperature.

The greenhouse heating system at the Oserian farm comprises various subsystems (Figure 3):

- A geothermal heating circuit located at the well site;
- A secondary fresh water heating circuit to transport heat from the well site to the greenhouse area;
- A large heat storage tank (3.8 million liters) to hold water at 92ºCelsius adjacent to the greenhouses;
- A distribution network to supply heat to the individual greenhouses as required; and
- Other secondary utilizFation accessories.

2.1.2 Carbon dioxide enrichment

Hot geothermal fluid comes out of the well and is piped to two plate heat exchangers, where it heats water coming from the 3.8 million litre water tank to about 92°C. The spent geothermal brine is then transported from the plate heat exchangers to a separator from which carbon dioxide is extracted from the top and liquid brine is removed from the bottom, through centrifugal action. The spent brine is then disposed in an environmentally acceptable way while the carbon dioxide is taken to the greenhouses. The fresh water heated inside the plate heat exchangers is taken back into the top of the water tank and mixed, through the use of mixing valves, with the cold water until a temperature of 50°C is attained, after which it is then fed into the greenhouses.

2.1.3 Sterilizing the fertilized water

Over 80 percent of Oserian's crops are grown using a technique known as "hydroponics", which replaces soil with another medium, enabling exactly the right quantities of nutrients to be supplied to the plants. The name "hydroponic" comes from Latin and means "working water". In reality hydroponics is the growing of plants without soil. When most people think of hydroponics, they think of plants grown with

their roots suspended directly into water with no growing medium. This is just one type of hydroponic gardening, known as the Nutrient Film Technique (N.F.T.), (Oserian, 2011)

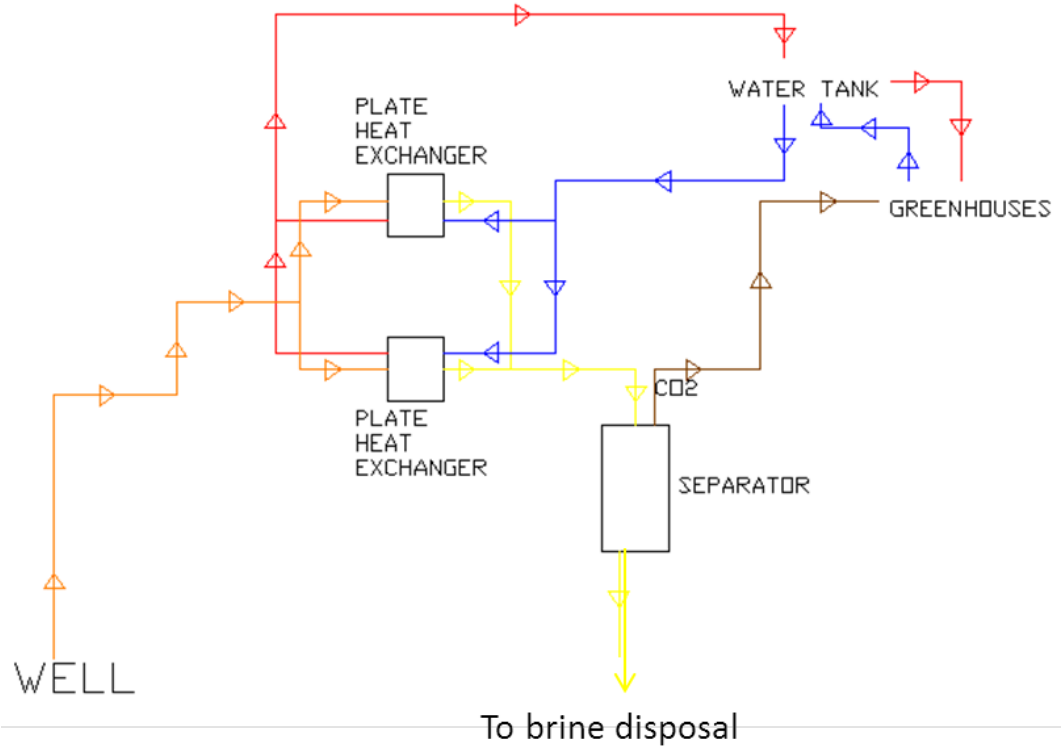

FIGURE 3: Schematic of the geothermal heating system at Oserian (Knight et al., 2006)

At Oserian, the hydroponics is achieved through the use of pumice in pots which supports the plants. Nutrients and water for the plants are in the form of the fertilized water. The excess fertilized water is recycled. To reduce the plants' infection, the recirculating fertilized water is passed through a geothermally heated sterilizer. This technique helps to improves yields and quality, while reducing the quantities of pesticides and fertilizers used as well as enabling water conservation through more efficient irrigation. This has proved to be economical in terms of water and the plants' nutrients.

2.1.4 Integrated Pest Management system

Oserian is also the world's largest Integrated Pest Management (IPM) farm. This activity involves the combination of plant nutrition with bio-control agents, which are biological substances designed to prevent and combat a range of diseases that affect flowers. A 2.5-acre greenhouse is devoted to producing more than 3 million *Phytoseiulus persimilis* parasitic mites that attack spider mites each week. The farm does not use miticides and saves 5 million Euros a year on the chemicals alone (Owles J., 2011). The temperature control in the IPM greenhouse is also regulated using geothermal heat.

Independent assessors from Bristol University have calculated that the carbon footprint of each Oserian rose including air freight is one tenth that of a rose grown in Holland where the greenhouses are artificially illuminated and heated 24 hours a day by electricity and kerosene.

2.1.5 Cooling storage and processing stores

After harvesting, cut flowers are pre-cooled to 3-5^{o}C before they are transported to the market. The pre-cooling helps preservation of the flowers so that they get to the market in the required condition. The temperature in the storage and processing rooms also need to be conditioned. This can be achieved through the use of absorption chillers.

Currently, all cold rooms at the flower farm are air conditioned using electricity. During dry seasons, electricity supply in Kenya is not reliable. The interruptions to electricity supply result in losses, reduction in the quality of stored flowers, or heavy investments in back-up power. Also, due to a high dependence on the dwindling fossil fuels for electricity generation, the cost of electricity in Kenya has increased quite significantly. The firms are therefore incurring hefty costs on pre-cooling bills.

Geothermal energy can be used as a source of heat (Figure 4) and is cheaper and more reliable for cooling storage rooms.

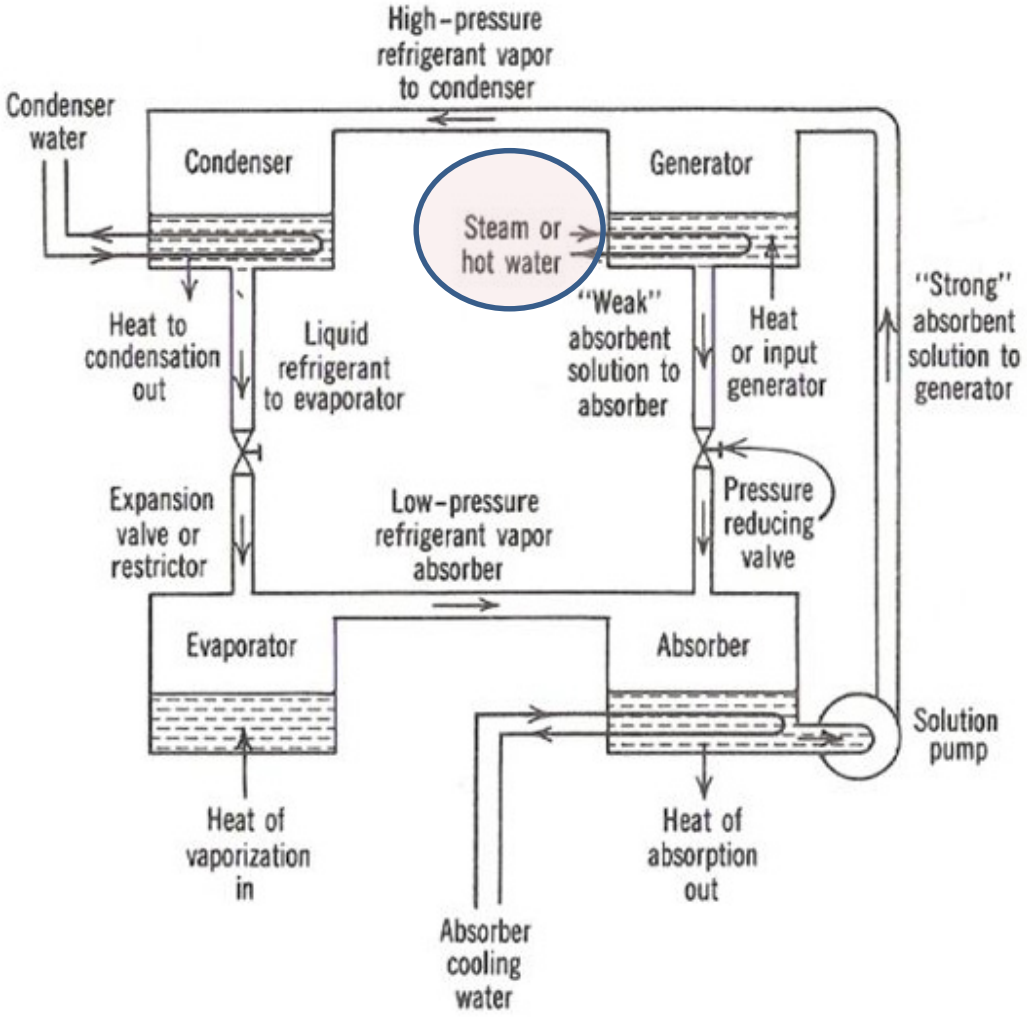

FIGURE 4: Basic absorption refrigeration cycle

3. UTILIZATION IN OTHER FARMS

Greenhouse heating of commercial greenhouses is done at New Mexico State University and at the Masson firm in the State of New Mexico. It has proved to be a viable investment both in the US and in Kenya.

There are more than 20 flower farms with a total of over 600 hectares located at a distance of less than 30 km from the Olkaria geothermal field. Some of these firms have expressed interest in the utilization of the geothermal energy for heating and cooling (Mburu, 2008). Supply of the energy to the farms is

technically viable but a study on the economic viability of such a venture needs to be undertaken before implementation.

The greenhouse farms are potential customers for geothermal greenhouse heating but energy supply and brine disposal systems need to be designed and evaluated to ensure that technical, financial and environmental concerns are addressed.

With the drilling of geothermal wells in Menengai, greenhouse farmers in Nakuru also offer a market for geothermal direct use applications. Geothermal Development Company (GDC) is setting up a greenhouse demonstration centre at Nakuru, Menengai geothermal. The greenhouses will be used to showcase greenhouse heating, sterilisation and cold storage.

4. REMARKS

The Oserian Flower Farm is a clear example for utilization of geothermal energy for both electricity generation and direct uses in a small scale. The geothermal resource is enormous in Kenya at about 10,000MW with high potential sites located mainly along the Kenya Rift Valley, which runs from the North to the South of the country. This energy, if utilized for both electricity generation and direct use can go a long way to replacing the use of fossil fuels and hence address global warming and curb overreliance on the diminishing fossil fuel reserves.

Many greenhouses exist and/or have a potential to be implemented at geothermal sites. The greenhouses can utilize geothermal energy to enhance productivity and profitability. An ongoing study has identified greenhouse heating as one of the most viable direct use applications in Kenya (USAID, 2014). From this study, GDC is setting up a 0.25 hectare greenhouse to be used as a marketing tool and to demonstrate the concept.

REFERENCES

Geothermal Development Associates, 2008: Geothermal power at Oserian farms, Naivasha, Kenya. *Presented at ARGeo C2 Conference, Entebbe, Uganda*, 32 pp. Web: http://www.bgr.de/geotherm/argeoc2/docs/sessions/s8_Oserian%20powerpoint.pdf

Knight, B., Hole, H.M., and Mills, T.D., 2006: *Geothermal greenhouse heating at Oserian Farm, Lake Naivasha, Kenya*. United Nations Univesity Geothermal Trainng Programme, Orkustofnun – National Energy Authority, Iceland, 5 pp. Web: http://www.os.is/gogn/flytja/JHS-Skjol/Yearbook2006/Oserian%20Greenhouse.pdf

Mburu, M., 2008: *Feasibility study on direct utilisation of energy from geothermal brine. A case study of Olkaria geothermal power plant, Kenya*. MSc Thesis.

Murua, J., 2011: *Oserian scores a first by introducing geothermal flower farming in the country*. Nairobi Living. Website: www.nairobiliving.com

Oserian: *Factfile*. Web: http://www.oserian.com/eco-friendly-processes.pdf