Use of Geothermal Steam for Nursery Heat Supply©

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INTRODUCTION

Taupo Native Plant Nursery is located approximately 5 km south west of Lake Taupo, in the central North Island. We produce mainly New Zealand native plants for ecological restoration throughout New Zealand. Currently we are producing approximately 2 million seedlings and 1 million in containers. Staff numbers vary between 55 and 75 depending on seasonal requirements.

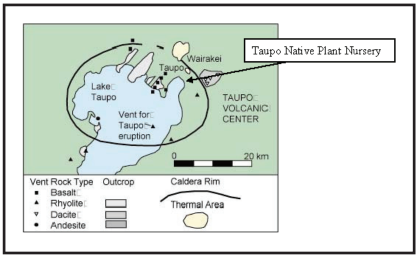

Figure 1. Taupo Volcanic Center and Taupo Native Plant Nursery location.

A VOLCANIC PLATEAU

Lake Taupo is actually a massive depression or caldera within the earth's crust that has formed as a direct consequence of repeated volcanic eruptions. In fact Taupo is considered to be the single most frequently active and productive volcano on earth today. Furthermore, within at least the last 5,000 years, Taupo has produced the most violent eruptions globally. It first began erupting about 300,000 years ago and last erupted about 1,800 years ago. On average it erupts every 900 years.

The Taupo Native Plant Nursery sits over the south west corner of the Tauhara-Wairakei geothermal field. Our winter temperatures regularly go down to -8 ^{o}C with a record low 2 years ago to -11.2 ^{o}C. February summer temperatures are normally around 30 ^{o}C. There are over 500 wells in and around the Taupo town area. Most are drilled into the shallow part of the resource, mainly used for hot tubs, etc, and a few deep wells mainly used for power production at five power plants. The hot ground water under the town and nursery is largely infiltrated rainwater, which has been heated by steam rising from the geothermal reservoir below. It has been estimated that the total energy used from the hot ground water is around 2.76×10^{8} MJ per year (276,000,000 MJ per year).

USING GEOTHERMAL STEAM

Taupo Native Plant Nursery has previously used its own shallow bore located on the nursery site. In the mid-1970s this bore collapsed, and rather than re-drill its own bore, it was decided to obtain steam from a deep investigation well located 800 m west of the nursery. This type of bore produces two phase fluid from the deep geothermal reservoir. This bore has since been sold to Contact Energy, an energy company. Due to Contact Energy's wanting to increase capacity in the area to cater for other users, including a wood processing mill and another future power station, they decided to drill another, larger geothermal well and make our existing well redundant. Thus we are now being supplied with two-phase steam from a new bore located just off the nursery's western boundary. The steam we use comes on to the nursery via a 50-mm pipe supply which is tapped off a 250-mm main line. The temperature at this point is a superheated 200 °C. The steam is then processed by passing the two-phase fluid through a water separator. This removes some liquid from the steam fluid and this makes the steam drier and easier to work with. The steam, which now has a temperature just above 130 °C, is then run to the nursery and manually regulated by a series of values. The steam pipe is either laid in, on, or above the ground depending on the desired use. Once the steam, which by this time has condensed to a small amount of fluid, has past through the various buildings, it is vented in to the nursery drainage systems.

Originally the nursery employed a heat exchanger and hot water system, but found it too difficult to accurately control and maintain. Other heat exchanger-type systems have been investigated but found to be either too expensive or not suitable due to Taupo's very cold winter conditions.

The steam is used in a number of ways, including:

- Greenhouse heating.
- Outside open ground heating for frost protection.
- Office block heating.
- Soil sterilization.
- Seed processing and drying.
- Display purposes (retail).

Problems. The use of geothermal steam for nursery production is not without its problems.

Compliance and Health and Safety Issues. The use of an extremely hot, corrosive, and potentially dangerous substance is not without strict compliance and related health and safety issues. The geothermal steam contains very dangerous, odourless poisonous hydrogen sulphide gas and lots of heavy metals such as arsenic, mercury, lead, boron, radium, etc.

Control of the Heat. Our steam comes into the nursery houses at just above 100 °C. It pushes itself around the various systems and ejects itself at various temperatures from 10 to 60 °C. Thus we control greenhouse temperatures by manual venting and greenhouse design.

Hot and Cold Spots. The pipes generally are spaced on top of the ground. These cause very hot dry conditions near the pipes and conversely can cause cold spots in corners, etc. To combat some of these issues we can bury the pipes in the ground. This causes the heat to more evenly disperse, but does reduce the heat value obtained. This is very effective for frost control both in greenhouses, cloches, or outside in the field.

Cost. The cost of the steam and associated structures is not cheap. In fact I have estimated that it is equivalent to using standard electricity type heating if all running and set up costs are included. We are currently in negotiations with Contact Energy regarding cost of the future steam supply. Costs have been estimated at $350 a tonne. We are also negotiating a cost of the enthalpy in the steam rather than a standard tonne rate.

Corrosive Nature. The steam contains, among other things, sulphuric acid, which is very corrosive. Standard galvanised piping generally lasts for about 8 years, sometimes less, which then needs replacing.

WHY USE GEOTHERMAL STEAM?

We have been encouraged by various organisations to do so because it is a renewable resource and does not attract carbon penalties. Once it is in place it does provide good heating and, more importantly for us, does provide adequate frost protection. No doubt if the geothermal systems were not already in place it is likely that the financial cost would prevent its use.

In the future we will continually investigate the possible development of our own shallow bore, cost being the major factor. As the technology of heat exchangers develops we may take a second look at this option as well.