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Event: Geothermal61
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Field Trip Name: Wairakei Geothermal Power
Field Trip Place: Wairakei
Diary number of total: 4 of 4
Weather: Fine and cool
Where's Donald: Taupo

Hi everybody

Every day of this trip our morning has started with a fascinating discussion about an aspect of energy, geothermal steam, every form of electricity generation and environmental issues. Today was just the same except we were with Murray Hill, generation engineer and Ed Mroczek, geothermal chemist.

I learnt that when Wairakei opened in 1956 their was no knowledge or experience with using geothermal water or steam. Therefore within a decade the power station had changed and depleted parts of the Wairakei steam field. Back then no reinjection of waste water was even considered. Today 60 percent of waste water goes back and in the future it will be 100 percent. This will have the two main benefits of recharging the underground reservoir and disposing of the 'nasties' like hydrogen sulfide and arsenic, back underground instead of into the Waikato River.

I wondered if geothermal power would end in NZ. Both Ed and Murray helped in the reply, ' The future is great for geothermal. Power prices are high so research and investment is worthwhile. In a decade we will double geothermal generation with new fields and new technologies. One well alone can produce 30MW of power now. Also we will go deeper to 3 or 4 km which means far fewer environmental effects. We can use far colder water also, just look at modern heat pumps in homes as an example. Ten years ago domestic heat pumps were rare now you can buy one anywhere, and they don't need geothermal water but use the same principles. Our 14MW Binary plant is just a big version of a heat pump.

Also the use of geothermal water will change. The mill at Kawerau is the world's largest industrial geothermal site, including the drying of wood with the hot water. Part of the Mokai geothermal field produces 2 million tonnes of tomatoes a year. However we do have problems such as only 11 percent of the heat becomes electricity, but that 's because you cannot remove all the heat and have everything still work. Drop the temperature below 87 and the silica settles out. Then there's the 'nasties' in a natural product like geothermal water, such as hydrogen sulfide and arsenic. Another problem is land subsidence caused by removing fluid from underground. Here at Wairakei in can be significant in some small, localised areas'

Murray raised another issue,' Over the past 30 years how we operate the plant has changed dramatically. Thirty years ago 60 people were needed in and around the control room but now it's nobody. It's all done by automatic systems or remotely. If something fails it fails in a safe way, that's what failsafe means.

Most equipment is connected to the internet through a portal. The equipment has its own URL or web address. It can be controlled or have its systems modified from anywhere. Last night the Israelies who designed the Binary plant over there made changes to the way it operates, all from Israel'. Murray paused then added with a smile, ' I still get phone calls at 3 am however'. With that he took us to Station A, but past the 220KV switchyard where he explained the various components in a video for us.

Once inside the control room of Station A we were confronted with three walls covered in large dials, circuits, buttons and knobs. One computer screen worked away unattended. It transpired the walls were now a ' mimic board' or backup system for what was done remotely. At times 2 people

can run Wairakei, Ohaaki and Poihipi Rd power stations , just with a click of a mouse. WE stepped through a doorway and Murray opened a wardrobe sized cabinet. This was the new heart of Wairakei. Neat colour coded bundles of skinny wires, a few LED's blinking and two connections where the fibre optic cables came and went. You can see them in the image opposite as red and yellow bundles in front of Murray. I was impressed with the change in technology but also with the enthusiasm and interest Murray had clearly shown to this change, in his career to date.

Next we were off with Ed Mroczek to see some geothermal chemistry at work. This involved a 5 minute drive to Wairakei Terraces, a commercial operation by local Maori using geothermal water. What we saw was striking natural cobalt blue pools , cascading hot water in streams , multicoloured plant life and dramatic silica terraces. As Ed explained,' The water comes from deep underground where it is 260 degrees and 26 Bar. At that temperature and pressure it can dissolve rocks, especially the silica in them. When it gets to the surface it is still 130 degrees, so it boils the instant it emerges creating the throbbing, surging, pulsating geyser at the top. The hot water cascades down dropping the silica off as it cools further. In the pools the dissolved silica has time to form colloids, which are tiny particles of silica about a micron in diameter. The colloids refract the blue light which gives the intense blue appearance. However on the terraces and streams it gets get deposited a sheets, but bacteria play a part. Bacteria that can live in this boiling water are called thermophiles and 20 years ago nobody believed they could exist. The bacterial colonies are like fine strands of hair. The silica is also soft and stringy as it starts to deposit on the bacterial strands, but eventually the silica cements the whole lot up like quartz. Look at the silica now and you can see the pattern of the original bacterial colonies. Down at the bottom algal colonies are growing each a different colour and each preferring a different temperature'.

We wandered along the gravelled path down to bottom of the terraces and Ed tied it all up nicely with,' Although this is beautiful remember that exactly this chemistry creates problems for us operating Wairakei. Let the water drop below 87 and the silica starts blocking everything up. On the Wairakei terraces its been about two years but in a reinjection well it can be 2 days. A 2 million dollar well that lasts only 2 days is not good and how can you fix a silica problem when it is 3 km down a pipe'.

Hopping in the car we drove straight to a reinjection well for a video and onto the outlet where 15 cumecs of power station water joins the Waikato river again. The places reeks of rotten eggs, indicating hydrogen sulfide abounds. The outlet water comes mainly from the steam condensers where the gas is captured. Ed explained,' New consents to operate the station mean we have to drop the hydrogen sulfide levels to the river about 200 times. If we can't do that we need to build another power station so its important. So over here we have a trial where we are getting local bacteria to remove it for us. It's called a bioreactor and the process is bioremediation. There are actually many species of bacteria at work'.

We wandered over to the bioreactor trial which was a shipping container sized metal box with hatches on top. Ed lifted the lid and their in the gently flowing water were banks of grey looking stuff, but no smell of hydrogen sulfide. I asked how well these bacteria were doing at removing the hydrogen sulfide and he gave me the numbers. I estimated they were dropping the level by 500 times. Very impressive little bacteria.

Sadly we could not investigate Ed's methods of trapping Arsenic and Mercury because it was off to our last field trip audioconference with Strath Tairei School.

A big thanks to all the Contact Energy staff at Wairakei Power Station who have made this geothermal field trip so successful and a special mention of the knowledgeable experts who have helped us each day. Thanks guys.

Cheers

Donald

Competition

1. I am dissolved from rocks deep underground
2. I am deposited when the water temperature drops
3. I can create problems for the reinjection of geothermal water.

Murray Hill showing how Wairakei power station is controlled today by a computer network

The original control board of Wairakei A station still works but is operated by remote computer networks now.

Ed Mroczek our guide to geothermal chemistry

A pool at the Wairakei Terrace complex that is blue due to tiny Silica molecules that refract blue light

Each colour shows a different temperature and therefore different algae, bacteria or chemical state.

The man made Wairakei Terraces are formed by silica being deposited by geothermal water

The patterns in the silica are determined by bacterial colonies which are then preserved

Inside the bioreactor pilot plant where grey bacteria can be seen growing profusely on the plastic screens

Standing on the Wairakei power station water outlet. looking up the Waikato River to the water intake building

A 3km deep reinjection well near the power station. The buildings behind are part of a prawn farm which also uses waste hot water.