GEOTHERMAL ENERGY LABORATORY

Thermodynamics and Surface Facilities

THIS IS A NEW AREA FOR OUR GROUP

CAN WE REDUCE EMISSIONS THROUGH MAXIMIZING THE AVAILABLE HEAT USE IN A PROCESS BEYOND CONVENTIONAL MEANS?

Thermodynamics and Surface Facilities

- In oil and gas production, whether there are hydrocarbons from hot formations (80^{o}C+) or thermal production (~200^{o}C) they generate an enormous amount of heat that needs to be cooled for further processing.

- As an example, Alberta generates over 520,000m^3 of bitumen daily. At an average Steam to Oil Ratio of 5.1, 2,652,000m^3 per day of hot emulsion is produced per day which is cooled to approximately 60^{o}C prior to further processing. This corresponds to 15.5*10^{8}MJ/day or 22*10^{5}MW of sustained energy that is essentially let to waste.

- The equivalent number of light hydrocarbons produced from Alberta alone is 50,000m^3 and with an average amount of water oil ratio to 6-10 this corresponds to an additional 1.2-3*10^{5}MW.

- The wasted energy out of all the chemical plants, power plants, refineries, etc. is not even considered. And it should.

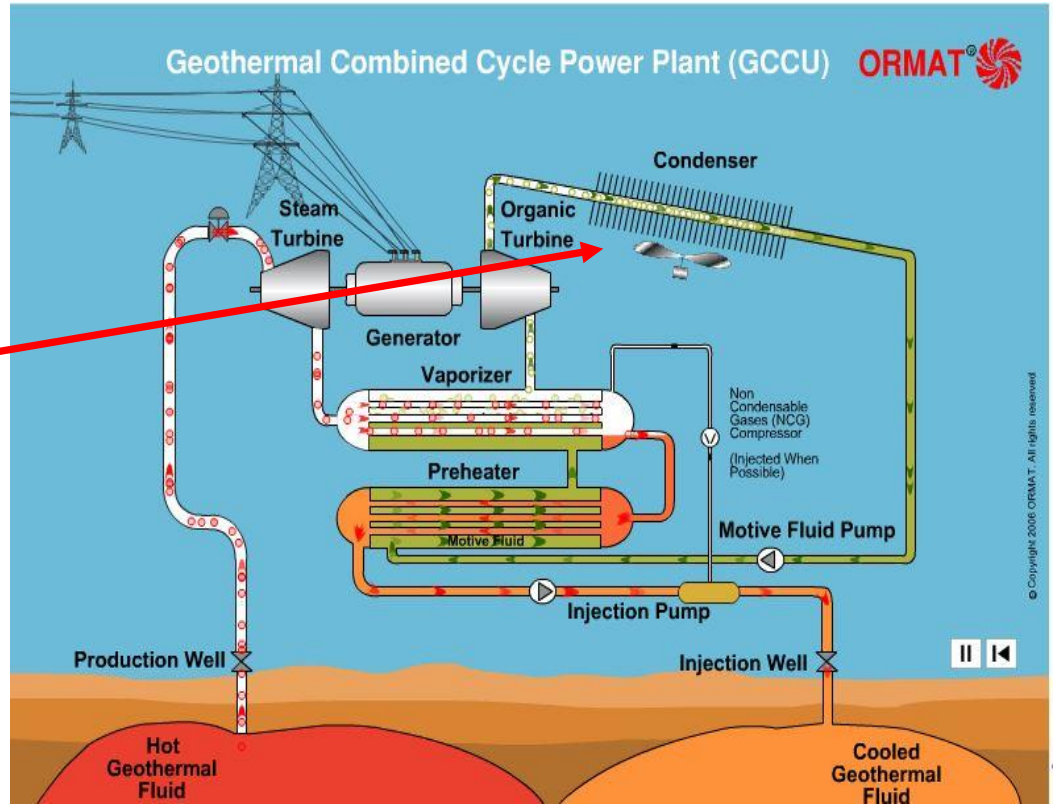
- Even if I am off by a factor of 100 the numbers are still very large. **So, the first thing to do is the generate a reliable inventory of these resources.**

Thermodynamics and Surface Facilities

- The problem is that there is no single source for all this energy but it is dispersed all over the province.
- **The traditional thinking in plant design says that the larger the better, so companies that build power plants walk away from this opportunity.**
- **But if we can build a single solar panel, why can't we build an equivalent geothermal panel?**
- Nonetheless, there are many low hanging fruits, such as SAGD plants, refineries, chemical plants, etc. that they are generating enough heat for harvesting an power generation.
- And then, of course, we have the geothermal energy.

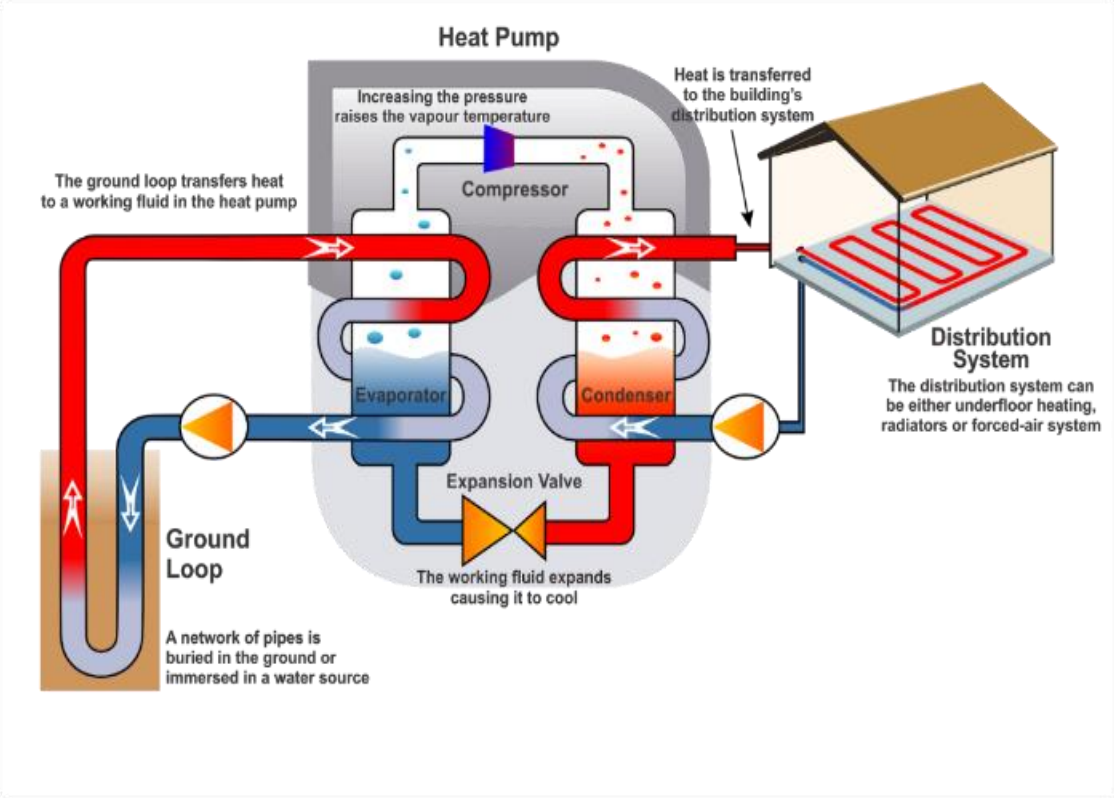
Thermodynamics and Surface Facilities

- The traditional approach is to get a heat source and the use the energy from that source to feed a power generator to generate electricity.
  - Geothermal source
  - Thermal bitumen source
  - An exothermic reactor
- The process efficiency is very low due to having to condense the steam in the "condenser".
- The condensing process "wastes" around 80% of the produced energy.
- All these issues need to be quantified as they are design parameters for future R&D.



Thermodynamics and Surface Facilities

- So one way to get the overall energy efficiency to a more acceptable level is to find other processes that can make good use of the energy dispersed in the “condenser”.
- The idea of house heating, roman baths, green houses, etc. can benefit the community and supply energy where it is otherwise wasted.
- Revenue can be generated for the protagonists in the same way that revenue is generated in the internet (which for those who are older was supposed to be “free access for all”).
- A more holistic approach than the “core business” must be adopted.



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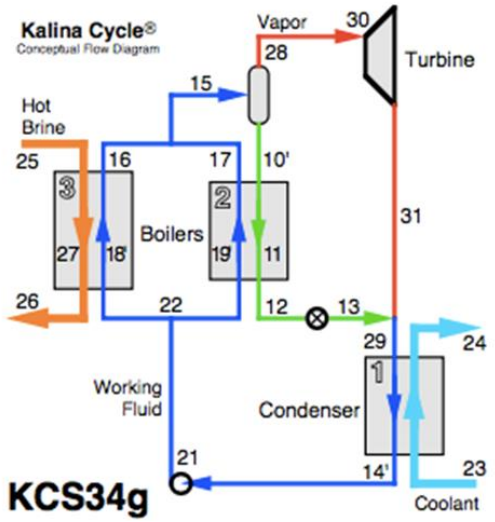
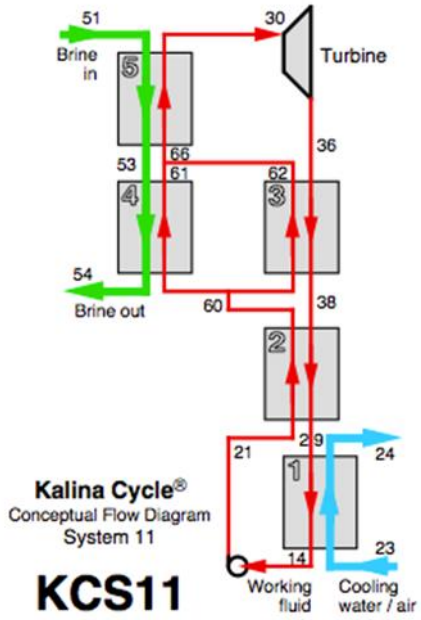
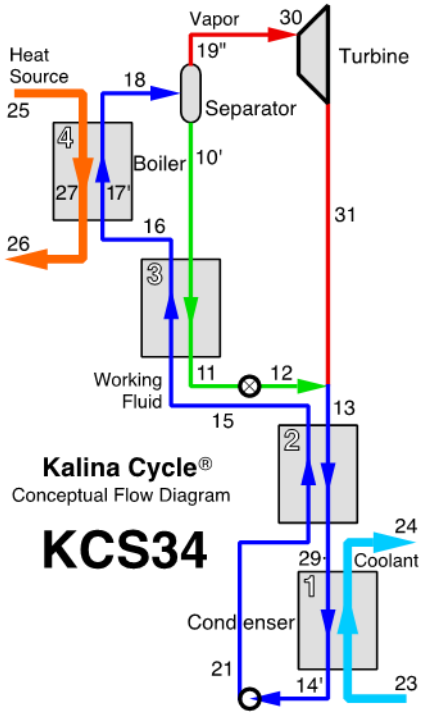
- There are many different power cycle systems.
- One of them is the Kalina Cycle (water ammonia working fluid).
- Some of the designs are presented here and they have advantages or disadvantages compared to other cycles.
- The Kalina cycle is the first cycle we will work on, but we are not bound to work only on this cycle.
- This is especially valid in our effort to generate a Geothermal Panel.







Source: Kalina Energy

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Thermodynamics and Surface Facilities

- **KEY QUESTIONS TO START ARE:**
- INVENTORY: How much, how dispersed, can be integrated, what options?
- ENERGY BALANCE MODELS: Quantify exactly how much energy per plant or unit operation.
- MINIATURIZATION: Build a system of a few kW or even less?
- SEQUESTRATION: Can we integrated CCS as part of our process?
- APPLICATIONS: Can we replace the condenser with some other energy harvester?
- INTEGRATIONS: Can we integrate multiple processes to replace the term “power efficiency” with a “process efficiency”?

My vision of the future chemical plant

UNIVERSITY OF CALGARY

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Thermodynamics and Surface Facilities

- We treat this as an emerging area.
- Our objective is to maximize the exergy recovery, recycling and harvesting for the province of Alberta (or anybody else interested) in a more holistic way.
- We propose an extensive research program focusing around this area.
- We already have the first two partners, and we are looking for more.

Research Areas

- **Thermodynamic energy recovery optimization.**
- **Use of residual heat.**
- **Surface facility design for minimal footprint and reduced noise.**
- **Miniaturization, integration and optimization.**
- **Alternative uses of how enthalpy heat.**