Steam Generation from Solar Trough Energy

The New Red B

Presentation Outline

- Customer and Team Goals Recap
- Our Steam Generator
- Alternative, rejected ideas
- Anticipated Challenges
- Mock-up Results
- Future Challenges

Customer

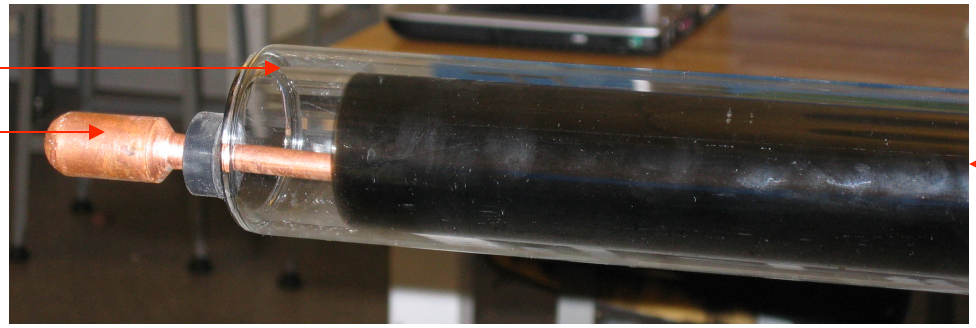
- Matt S. Orosz (MIT G, Engineering Systems)
- Working with Bethel Business and Community Development Center in Lesotho (southern Africa) to enable parabolic trough applications

Our Goal – Create More Applications for Parabolic Trough

- Electricity
- Micro Hydro Power – hammer mills, power tools
- Heating water
- Devices for clinics and schools

Our Steam Generator

- Use Apricus solar absorption tube to produce steam within boiler
- Water boiler designed to connect to interchangeable devices
- Concentration: Sterilization



Alternatives Considered-Steam Engine

- Financially feasible
- Not enough solar energy to power a 1 hp engine
  - Closed loop efficiency ~5%
  - Open loop efficiency ~2%
- Integrating system components (pumps, condensers) also not feasible for this class

Alternatives Considered – Sterling Engine

- Simpler principle than steam engine
- Not financially feasible
  - Low HP engines > $35,000
- Technology not yet available (2005?)
  - Still in R&D phase
- Maximum efficiency ~ 10%, still not enough output

Anticipated Challenges

- Heat Transfer, how?
  - From nub to water to generating steam
- Pressurized Steam - ASME Codes
- Tube Safety
  - Max operating temperature of 250°C
  - Fragile Casing – Borosilicate glass
    - Maximum Strength 0.8 MPa

Our Mock-Up

- Water is working fluid (20 oz)
- “Solar” source: 250W heat lamps (4)
- Gravity fed
- Nub conducts heat to water until it reaches boiling temperature
- Nucleate boiling

Boiler not pictured.

Knowledge from Mockup and Calculations

- Boiler is currently heating water
- Time to initially reach boiling significant
  - Not using solar reflector, means less heat absorption
  - Using less than 1/20 of actual energy
- Predict it will not film boil

Challenges Still to be Resolved

- Experimentally confirm will not film boil at maximum anticipated solar heat flux
- Make sterilizer from pressure cooker
- Pressurization of system to 45 psi (135°C) to run for cooker